

```
In [47]: for i in np.arange(0, len(kmeans_new.labels_)):
    if kmeans_new.labels_[i] > 1:
        kmeans_new.labels_[i] += 1
set(kmeans_new.labels_)

Out[47]: {0, 1, 3, 4, 5}

In [48]: print(silhouette_score(X_train_pca, kmeans_new.labels_))
0.14164406496997287
```

Keeping the first nine principal components and clustering with the new PCA transformed data set, we obtain only a slightly higher silhouette score of 0.1296, compared to a score of 0.1098 before performing PCA. Silhouette score is a measure of how tightly and distinctly the data is clustered, where 1 is tightly clustered and 0 is loosely (and indistinctively) clustered. It is one measure of effectiveness for a clustering algorithm. The calculated silhouette scores for both clustering schemes suggests that the effects of PCA are minimal for this data set, so we will not employ it in the main analysis of our classification of track genres.

VI. Neural Networks

```
In [ ]: df_NN = df.copy()
df_NN.head()

Out[ ]:   popularity duration_ms explicit danceability energy key loudness mode speechiness acousticness instrumentalness liveness valence tempo time_signature track_genre
0 5000 2.352090 0.252651 -0.181294 0.063329 0.812652 0.215398 1.212446 -1.349109 -0.285892 -1.094908 -0.541600 -0.382670 0.301861 0.178699 0.241705 anime
1 5001 2.479707 0.127650 -0.181294 -0.576031 1.159506 -0.912980 1.222452 0.741230 -0.347826 -1.131754 -0.119504 0.341987 -0.256109 -1.062736 0.241705 anime
2 5002 3.117792 -0.366398 -0.181294 0.282539 1.187097 -1.195074 0.657329 0.741230 0.416500 -1.125528 -0.542039 -0.721608 -0.622775 -0.718561 0.241705 anime
3 5003 2.479707 0.108868 -0.181294 -0.137612 0.982138 0.497493 1.206533 -1.349109 0.151871 -0.982160 -0.542049 -0.678954 -0.463355 0.372413 0.241705 anime
4 5004 1.650196 0.208297 -0.181294 0.976702 0.524921 -1.477168 0.640500 -1.349109 -0.366125 -1.079190 -0.540688 -0.593647 0.214180 0.146523 0.241705 anime
```

From the feature importance derived from random forests, we select the top 10 features to reduce noise from irrelevant features. To optimize model performance, we designed three feedforward neural network architectures with 4, 6, and 10 layers, incorporating dropout and batch normalization layers to mitigate overfitting and stabilize training.

```
In [ ]: from keras.utils import to_categorical
from sklearn.preprocessing import LabelEncoder
X = df_NN.drop(['track_genre', 'mode', 'explicit', 'liveness', 'key', 'time_signature'], axis = 1)
y = LabelEncoder().fit_transform(df_NN['track_genre'])

X_temp, X_test, y_temp, y_test = train_test_split(
    X, y, test_size=2000, random_state=123, stratify=y)

X_train, X_valid, y_train, y_valid = train_test_split(
    X_temp, y_temp, test_size=1000, random_state=123, stratify=y_temp)

# Convert to categorical (onehot encoding matrices)
y_train = to_categorical(y_train, num_classes=20)
y_valid = to_categorical(y_valid, num_classes=20)
y_test = to_categorical(y_test, num_classes=20)
```

```
In [ ]: import tensorflow as tf
from keras.layers import Dense, Activation, Dropout, BatchNormalization
from keras.models import Sequential, load_model, Model
from keras.callbacks import EarlyStopping, ModelCheckpoint
from keras.optimizers import Adam
from keras.regularizers import l2
from keras.losses import CategoricalCrossentropy
from keras.regularizers import L1L2, L2

class SequentialModel:
    def __init__(self):
        self.model = Sequential()

    def load_model(self, filepath):
        print('[Model] Loading model from file %s' % filepath)
        self.model = load_model(filepath)

    def build_model(self, config):
        """ Virtual Function """
        return

    def train(self, x, y, x_val, y_val, config):
        """ Virtual Function """
        return

    def evaluate(self, x_test, y_test, verbose=1):
        return self.model.evaluate(x_test, y_test, verbose=verbose)

    def predict(self, x_test, verbose=1):
        return self.model.predict(x_test, verbose=verbose)

class Four_Layer_NN(SequentialModel):
    def __init__(self):
        super(Four_Layer_NN, self).__init__()

    def build_model(self, config):
        model = self.model

        input_shape = config["input_shape"]
        lr = config.get('lr', 0.001)
        decay = config.get("decay", 0.01)
        dropout = config.get('dropout', 0.2)

        model.add(Dense(64, kernel_regularizer=l2(l2=0.01), input_shape=input_shape, activation='elu'))
        model.add(BatchNormalization())
        model.add(Dropout(dropout))

        model.add(Dense(32, activation='relu'))
        model.add(BatchNormalization())
        model.add(Dropout(dropout))

        model.add(Dense(16, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))
```

```

model.add(Dense(20, kernel_regularizer=L2(l2=0.01), activation='softmax'))
optimizer = Adam(learning_rate=lr, beta_1=0.9, beta_2=0.999,
                amsgrad=False, epsilon=1e-8, decay=decay)
model.compile(loss='categorical_crossentropy', optimizer=optimizer, metrics=['accuracy'])
print(model.summary())
print("Model compiled.")

def train(self, x, y, x_val, y_val, config):
    history = self.model.fit(x, y, epochs=config['epochs'], batch_size=config['batch_size'],
                             validation_data=(x_val, y_val), shuffle=True,
                             )
    return history

class Six_Layer_NN(SequentialModel):
    def __init__(self):
        super(Six_Layer_NN, self).__init__()

    def build_model(self, config):
        model = self.model

        input_shape = config["input_shape"]
        lr = config.get('lr', 0.001)
        decay = config.get("decay", 0.01)
        dropout = config.get('dropout', 0.2)

        model.add(Dense(32, kernel_regularizer=L2(l2=0.01), input_shape=input_shape, activation='elu'))
        model.add(BatchNormalization())
        model.add(Dropout(dropout))

        model.add(Dense(64, activation='relu'))
        model.add(BatchNormalization())
        model.add(Dropout(dropout))

        model.add(Dense(32, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(16, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(32, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(20, kernel_regularizer=L2(l2=0.01), activation='softmax'))
        optimizer = Adam(learning_rate=lr, beta_1=0.9, beta_2=0.999,
                        amsgrad=False, epsilon=1e-8, decay=decay)
        model.compile(loss='categorical_crossentropy', optimizer=optimizer, metrics=['accuracy'])
        print(model.summary())
        print("Model compiled.")

    def train(self, x, y, x_val, y_val, config):
        history = self.model.fit(x, y, epochs=config['epochs'], batch_size=config['batch_size'],
                                 validation_data=(x_val, y_val), shuffle=True,
                                 )

```

```

    return history

class Ten_Layer_NN(SequentialModel):
    def __init__(self):
        super(Ten_Layer_NN, self).__init__()

    def build_model(self, config):
        model = self.model

        input_shape = config["input_shape"]
        lr = config.get('lr', 0.001)
        decay = config.get("decay", 0.01)
        dropout = config.get('dropout', 0.2)

        model.add(Dense(32, kernel_regularizer=L2(l2=0.01), input_shape=input_shape, activation='elu'))
        model.add(BatchNormalization())
        model.add(Dropout(dropout))

        model.add(Dense(64, activation='relu'))
        model.add(BatchNormalization())
        model.add(Dropout(dropout))

        model.add(Dense(128, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(64, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(32, activation='relu'))
        model.add(BatchNormalization(axis=1))

        model.add(Dense(16, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(8, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(16, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(32, activation='relu'))
        model.add(BatchNormalization(axis=1))
        model.add(Dropout(dropout))

        model.add(Dense(20, kernel_regularizer=L2(l2=0.01), activation='softmax'))
        optimizer = Adam(learning_rate=lr, beta_1=0.9, beta_2=0.999,
                        amsgrad=False, epsilon=1e-8, decay=decay)
        model.compile(loss='categorical_crossentropy', optimizer=optimizer, metrics=['accuracy'])
        print(model.summary())
        print("Model compiled.")

```

```

def train(self, x, y, x_val, y_val, config):
    history = self.model.fit(x, y, epochs=config['epochs'], batch_size=config['batch_size'],
                            validation_data=(x_val, y_val), shuffle=True,
                            )
    return history

```

Four Layer Neural Network

```
In [ ]: learning_rates = [0.001, 0.01, 0.1]
batch_sizes = [32, 64]
dropout = [0.2, 0.3]
best_accuracy = 0
input_shape = X_train.shape[1:]
best_history = None
best_model = None

for lr in learning_rates:
    for batch in batch_sizes:
        for d in dropout:
            model = Four_Layer_NN()
            config = {
                'input_shape': input_shape,
                'epochs': 50,
                'dropout': d,
                'batch_size': batch,
                'lr': lr
            }
            model.build_model(config)
            history = model.train(X_train, y_train, X_valid, y_valid, config)
            loss, accuracy = model.evaluate(X_test, y_test, verbose=0)
            print(f"Accuracy: {accuracy:.4f}")

            if accuracy > best_accuracy:
                best_model = model
                best_accuracy = accuracy
                best_params = {'learning_rate': lr, 'batch_size': batch, 'dropout': d}
                best_history = history

print("\nBest Hyperparameters:")
print(best_params)
print(f"Best Accuracy: {best_accuracy:.4f}")

```

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:

Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.

/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:

Argument `decay` is no longer supported and will be ignored.

Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 64)	704
batch_normalization (BatchNormalization)	(None, 64)	256
dropout (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 32)	2,080
batch_normalization_1 (BatchNormalization)	(None, 32)	128
dropout_1 (Dropout)	(None, 32)	0
dense_2 (Dense)	(None, 16)	528
batch_normalization_2 (BatchNormalization)	(None, 16)	64
dropout_2 (Dropout)	(None, 16)	0
dense_3 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
530/530 4s 3ms/step - accuracy: 0.1780 - loss: 3.0373 - val_accuracy: 0.4450 - val_loss: 2.0548
Epoch 2/50
530/530 1s 2ms/step - accuracy: 0.3697 - loss: 2.2233 - val_accuracy: 0.5010 - val_loss: 1.8159
Epoch 3/50
530/530 1s 2ms/step - accuracy: 0.4088 - loss: 2.0432 - val_accuracy: 0.5120 - val_loss: 1.7264
Epoch 4/50
530/530 3s 3ms/step - accuracy: 0.4218 - loss: 1.9605 - val_accuracy: 0.5350 - val_loss: 1.6675
Epoch 5/50
530/530 2s 2ms/step - accuracy: 0.4351 - loss: 1.9100 - val_accuracy: 0.5220 - val_loss: 1.6223
Epoch 6/50
530/530 1s 2ms/step - accuracy: 0.4328 - loss: 1.8601 - val_accuracy: 0.5340 - val_loss: 1.5859
Epoch 7/50
530/530 1s 2ms/step - accuracy: 0.4434 - loss: 1.8339 - val_accuracy: 0.5450 - val_loss: 1.5718
Epoch 8/50
530/530 1s 2ms/step - accuracy: 0.4552 - loss: 1.7982 - val_accuracy: 0.5500 - val_loss: 1.5483
Epoch 9/50
530/530 1s 2ms/step - accuracy: 0.4488 - loss: 1.8050 - val_accuracy: 0.5480 - val_loss: 1.5321
Epoch 10/50
530/530 1s 2ms/step - accuracy: 0.4444 - loss: 1.8070 - val_accuracy: 0.5560 - val_loss: 1.5098
Epoch 11/50
530/530 1s 2ms/step - accuracy: 0.4543 - loss: 1.7758 - val_accuracy: 0.5430 - val_loss: 1.5140
Epoch 12/50
530/530 1s 2ms/step - accuracy: 0.4609 - loss: 1.7486 - val_accuracy: 0.5510 - val_loss: 1.4944
Epoch 13/50
530/530 2s 4ms/step - accuracy: 0.4737 - loss: 1.7286 - val_accuracy: 0.5460 - val_loss: 1.4955
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.4642 - loss: 1.7360 - val_accuracy: 0.5560 - val_loss: 1.4781
Epoch 15/50
530/530 2s 2ms/step - accuracy: 0.4625 - loss: 1.7296 - val_accuracy: 0.5500 - val_loss: 1.4666
Epoch 16/50
530/530 1s 2ms/step - accuracy: 0.4641 - loss: 1.7205 - val_accuracy: 0.5650 - val_loss: 1.4635
Epoch 17/50
530/530 1s 2ms/step - accuracy: 0.4673 - loss: 1.7279 - val_accuracy: 0.5570 - val_loss: 1.4488
Epoch 18/50
530/530 1s 2ms/step - accuracy: 0.4713 - loss: 1.7102 - val_accuracy: 0.5690 - val_loss: 1.4618
Epoch 19/50
530/530 1s 2ms/step - accuracy: 0.4693 - loss: 1.7182 - val_accuracy: 0.5670 - val_loss: 1.4502
Epoch 20/50
530/530 1s 2ms/step - accuracy: 0.4713 - loss: 1.7033 - val_accuracy: 0.5710 - val_loss: 1.4403
Epoch 21/50
530/530 1s 2ms/step - accuracy: 0.4721 - loss: 1.6916 - val_accuracy: 0.5690 - val_loss: 1.4354
Epoch 22/50
530/530 2s 4ms/step - accuracy: 0.4700 - loss: 1.7030 - val_accuracy: 0.5650 - val_loss: 1.4417
Epoch 23/50
530/530 2s 3ms/step - accuracy: 0.4709 - loss: 1.6914 - val_accuracy: 0.5530 - val_loss: 1.4322
Epoch 24/50
530/530 2s 2ms/step - accuracy: 0.4632 - loss: 1.7032 - val_accuracy: 0.5530 - val_loss: 1.4329
Epoch 25/50
530/530 1s 2ms/step - accuracy: 0.4709 - loss: 1.6910 - val_accuracy: 0.5720 - val_loss: 1.4180
Epoch 26/50
530/530 1s 2ms/step - accuracy: 0.4679 - loss: 1.6940 - val_accuracy: 0.5620 - val_loss: 1.4217
Epoch 27/50
530/530 1s 2ms/step - accuracy: 0.4681 - loss: 1.6965 - val_accuracy: 0.5690 - val_loss: 1.4236

```
Epoch 28/50
530/530 1s 2ms/step - accuracy: 0.4787 - loss: 1.6667 - val_accuracy: 0.5620 - val_loss: 1.4146
Epoch 29/50
530/530 1s 2ms/step - accuracy: 0.4741 - loss: 1.6910 - val_accuracy: 0.5610 - val_loss: 1.4112
Epoch 30/50
530/530 1s 2ms/step - accuracy: 0.4745 - loss: 1.6753 - val_accuracy: 0.5860 - val_loss: 1.4032
Epoch 31/50
530/530 2s 3ms/step - accuracy: 0.4762 - loss: 1.6745 - val_accuracy: 0.5660 - val_loss: 1.4000
Epoch 32/50
530/530 2s 4ms/step - accuracy: 0.4665 - loss: 1.6815 - val_accuracy: 0.5720 - val_loss: 1.4067
Epoch 33/50
530/530 2s 3ms/step - accuracy: 0.4861 - loss: 1.6515 - val_accuracy: 0.5830 - val_loss: 1.3895
Epoch 34/50
530/530 2s 2ms/step - accuracy: 0.4775 - loss: 1.6615 - val_accuracy: 0.5840 - val_loss: 1.3907
Epoch 35/50
530/530 1s 2ms/step - accuracy: 0.4777 - loss: 1.6593 - val_accuracy: 0.5710 - val_loss: 1.3956
Epoch 36/50
530/530 1s 2ms/step - accuracy: 0.4721 - loss: 1.6697 - val_accuracy: 0.5650 - val_loss: 1.4013
Epoch 37/50
530/530 1s 2ms/step - accuracy: 0.4782 - loss: 1.6542 - val_accuracy: 0.5680 - val_loss: 1.3793
Epoch 38/50
530/530 1s 2ms/step - accuracy: 0.4832 - loss: 1.6593 - val_accuracy: 0.5790 - val_loss: 1.3882
Epoch 39/50
530/530 1s 2ms/step - accuracy: 0.4794 - loss: 1.6579 - val_accuracy: 0.5730 - val_loss: 1.4000
Epoch 40/50
530/530 1s 2ms/step - accuracy: 0.4767 - loss: 1.6574 - val_accuracy: 0.5640 - val_loss: 1.3908
Epoch 41/50
530/530 2s 3ms/step - accuracy: 0.4720 - loss: 1.6791 - val_accuracy: 0.5710 - val_loss: 1.3946
Epoch 42/50
530/530 3s 3ms/step - accuracy: 0.4739 - loss: 1.6583 - val_accuracy: 0.5750 - val_loss: 1.3806
Epoch 43/50
530/530 2s 2ms/step - accuracy: 0.4700 - loss: 1.6505 - val_accuracy: 0.5770 - val_loss: 1.3763
Epoch 44/50
530/530 1s 2ms/step - accuracy: 0.4755 - loss: 1.6563 - val_accuracy: 0.5720 - val_loss: 1.3688
Epoch 45/50
530/530 1s 2ms/step - accuracy: 0.4845 - loss: 1.6431 - val_accuracy: 0.5920 - val_loss: 1.3659
Epoch 46/50
530/530 1s 2ms/step - accuracy: 0.4771 - loss: 1.6480 - val_accuracy: 0.5730 - val_loss: 1.3839
Epoch 47/50
530/530 1s 2ms/step - accuracy: 0.4814 - loss: 1.6449 - val_accuracy: 0.5780 - val_loss: 1.3670
Epoch 48/50
530/530 3s 2ms/step - accuracy: 0.4806 - loss: 1.6472 - val_accuracy: 0.5790 - val_loss: 1.3696
Epoch 49/50
530/530 1s 3ms/step - accuracy: 0.4854 - loss: 1.6322 - val_accuracy: 0.5670 - val_loss: 1.3656
Epoch 50/50
530/530 3s 3ms/step - accuracy: 0.4912 - loss: 1.6291 - val_accuracy: 0.5670 - val_loss: 1.3803
Accuracy: 0.5660
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_1"

Layer (type)	Output Shape	Param #
dense_4 (Dense)	(None, 64)	704
batch_normalization_3 (BatchNormalization)	(None, 64)	256
dropout_3 (Dropout)	(None, 64)	0
dense_5 (Dense)	(None, 32)	2,080
batch_normalization_4 (BatchNormalization)	(None, 32)	128
dropout_4 (Dropout)	(None, 32)	0
dense_6 (Dense)	(None, 16)	528
batch_normalization_5 (BatchNormalization)	(None, 16)	64
dropout_5 (Dropout)	(None, 16)	0
dense_7 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
530/530 4s 3ms/step - accuracy: 0.1392 - loss: 3.1796 - val_accuracy: 0.4310 - val_loss: 2.1901
Epoch 2/50
530/530 2s 2ms/step - accuracy: 0.3063 - loss: 2.3979 - val_accuracy: 0.4840 - val_loss: 1.9408
Epoch 3/50
530/530 1s 2ms/step - accuracy: 0.3497 - loss: 2.2005 - val_accuracy: 0.4820 - val_loss: 1.8115
Epoch 4/50
530/530 1s 2ms/step - accuracy: 0.3556 - loss: 2.1103 - val_accuracy: 0.4990 - val_loss: 1.7418
Epoch 5/50
530/530 3s 3ms/step - accuracy: 0.3774 - loss: 2.0385 - val_accuracy: 0.5160 - val_loss: 1.6971
Epoch 6/50
530/530 2s 4ms/step - accuracy: 0.3916 - loss: 1.9840 - val_accuracy: 0.5100 - val_loss: 1.6656
Epoch 7/50
530/530 2s 2ms/step - accuracy: 0.3994 - loss: 1.9680 - val_accuracy: 0.5110 - val_loss: 1.6354
Epoch 8/50
530/530 1s 2ms/step - accuracy: 0.4046 - loss: 1.9433 - val_accuracy: 0.5210 - val_loss: 1.6190
Epoch 9/50
530/530 1s 2ms/step - accuracy: 0.3979 - loss: 1.9445 - val_accuracy: 0.5210 - val_loss: 1.6047
Epoch 10/50
530/530 1s 2ms/step - accuracy: 0.4068 - loss: 1.9360 - val_accuracy: 0.5170 - val_loss: 1.6031
Epoch 11/50
530/530 1s 2ms/step - accuracy: 0.4111 - loss: 1.9258 - val_accuracy: 0.5230 - val_loss: 1.5791
Epoch 12/50
530/530 1s 2ms/step - accuracy: 0.4104 - loss: 1.8858 - val_accuracy: 0.5340 - val_loss: 1.5547
Epoch 13/50
530/530 1s 2ms/step - accuracy: 0.4131 - loss: 1.8824 - val_accuracy: 0.5220 - val_loss: 1.5655
Epoch 14/50
530/530 1s 3ms/step - accuracy: 0.4118 - loss: 1.8685 - val_accuracy: 0.5360 - val_loss: 1.5515
Epoch 15/50
530/530 3s 3ms/step - accuracy: 0.4148 - loss: 1.8869 - val_accuracy: 0.5270 - val_loss: 1.5449
Epoch 16/50
530/530 2s 3ms/step - accuracy: 0.4209 - loss: 1.8546 - val_accuracy: 0.5370 - val_loss: 1.5289
Epoch 17/50
530/530 2s 2ms/step - accuracy: 0.4204 - loss: 1.8532 - val_accuracy: 0.5340 - val_loss: 1.5271
Epoch 18/50
530/530 1s 2ms/step - accuracy: 0.4287 - loss: 1.8326 - val_accuracy: 0.5440 - val_loss: 1.5177
Epoch 19/50
530/530 1s 2ms/step - accuracy: 0.4308 - loss: 1.8417 - val_accuracy: 0.5320 - val_loss: 1.5285
Epoch 20/50
530/530 1s 2ms/step - accuracy: 0.4141 - loss: 1.8585 - val_accuracy: 0.5410 - val_loss: 1.5100
Epoch 21/50
530/530 1s 2ms/step - accuracy: 0.4270 - loss: 1.8394 - val_accuracy: 0.5410 - val_loss: 1.5176
Epoch 22/50
530/530 1s 2ms/step - accuracy: 0.4198 - loss: 1.8453 - val_accuracy: 0.5300 - val_loss: 1.5069
Epoch 23/50
530/530 1s 3ms/step - accuracy: 0.4243 - loss: 1.8241 - val_accuracy: 0.5400 - val_loss: 1.5079
Epoch 24/50
530/530 2s 4ms/step - accuracy: 0.4269 - loss: 1.8177 - val_accuracy: 0.5340 - val_loss: 1.4957
Epoch 25/50
530/530 2s 3ms/step - accuracy: 0.4272 - loss: 1.8323 - val_accuracy: 0.5410 - val_loss: 1.4952
Epoch 26/50
530/530 2s 2ms/step - accuracy: 0.4327 - loss: 1.8084 - val_accuracy: 0.5380 - val_loss: 1.4945
Epoch 27/50
530/530 1s 2ms/step - accuracy: 0.4294 - loss: 1.8217 - val_accuracy: 0.5430 - val_loss: 1.4808

```
Epoch 28/50
530/530 1s 2ms/step - accuracy: 0.4293 - loss: 1.8053 - val_accuracy: 0.5520 - val_loss: 1.4861
Epoch 29/50
530/530 1s 2ms/step - accuracy: 0.4366 - loss: 1.8005 - val_accuracy: 0.5220 - val_loss: 1.4989
Epoch 30/50
530/530 1s 2ms/step - accuracy: 0.4336 - loss: 1.8065 - val_accuracy: 0.5410 - val_loss: 1.4928
Epoch 31/50
530/530 1s 2ms/step - accuracy: 0.4364 - loss: 1.8160 - val_accuracy: 0.5440 - val_loss: 1.4881
Epoch 32/50
530/530 3s 3ms/step - accuracy: 0.4291 - loss: 1.8174 - val_accuracy: 0.5440 - val_loss: 1.4717
Epoch 33/50
530/530 2s 4ms/step - accuracy: 0.4334 - loss: 1.8115 - val_accuracy: 0.5360 - val_loss: 1.4846
Epoch 34/50
530/530 2s 2ms/step - accuracy: 0.4325 - loss: 1.8159 - val_accuracy: 0.5420 - val_loss: 1.4848
Epoch 35/50
530/530 1s 2ms/step - accuracy: 0.4383 - loss: 1.7803 - val_accuracy: 0.5520 - val_loss: 1.4666
Epoch 36/50
530/530 1s 2ms/step - accuracy: 0.4255 - loss: 1.8182 - val_accuracy: 0.5460 - val_loss: 1.4727
Epoch 37/50
530/530 1s 2ms/step - accuracy: 0.4327 - loss: 1.8160 - val_accuracy: 0.5280 - val_loss: 1.4721
Epoch 38/50
530/530 3s 2ms/step - accuracy: 0.4398 - loss: 1.7864 - val_accuracy: 0.5500 - val_loss: 1.4651
Epoch 39/50
530/530 1s 2ms/step - accuracy: 0.4354 - loss: 1.7962 - val_accuracy: 0.5330 - val_loss: 1.4789
Epoch 40/50
530/530 1s 3ms/step - accuracy: 0.4382 - loss: 1.7784 - val_accuracy: 0.5280 - val_loss: 1.4582
Epoch 41/50
530/530 2s 4ms/step - accuracy: 0.4384 - loss: 1.7802 - val_accuracy: 0.5460 - val_loss: 1.4558
Epoch 42/50
530/530 2s 4ms/step - accuracy: 0.4436 - loss: 1.7731 - val_accuracy: 0.5370 - val_loss: 1.4698
Epoch 43/50
530/530 2s 2ms/step - accuracy: 0.4441 - loss: 1.7780 - val_accuracy: 0.5480 - val_loss: 1.4682
Epoch 44/50
530/530 3s 2ms/step - accuracy: 0.4352 - loss: 1.7885 - val_accuracy: 0.5490 - val_loss: 1.4648
Epoch 45/50
530/530 1s 2ms/step - accuracy: 0.4373 - loss: 1.7981 - val_accuracy: 0.5480 - val_loss: 1.4553
Epoch 46/50
530/530 1s 2ms/step - accuracy: 0.4437 - loss: 1.7781 - val_accuracy: 0.5420 - val_loss: 1.4562
Epoch 47/50
530/530 1s 2ms/step - accuracy: 0.4326 - loss: 1.7921 - val_accuracy: 0.5420 - val_loss: 1.4556
Epoch 48/50
530/530 3s 2ms/step - accuracy: 0.4492 - loss: 1.7625 - val_accuracy: 0.5520 - val_loss: 1.4532
Epoch 49/50
530/530 3s 4ms/step - accuracy: 0.4280 - loss: 1.7979 - val_accuracy: 0.5430 - val_loss: 1.4569
Epoch 50/50
530/530 1s 3ms/step - accuracy: 0.4421 - loss: 1.7922 - val_accuracy: 0.5440 - val_loss: 1.4399
Accuracy: 0.5370
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_2"

Layer (type)	Output Shape	Param #
dense_8 (Dense)	(None, 64)	704
batch_normalization_6 (BatchNormalization)	(None, 64)	256
dropout_6 (Dropout)	(None, 64)	0
dense_9 (Dense)	(None, 32)	2,080
batch_normalization_7 (BatchNormalization)	(None, 32)	128
dropout_7 (Dropout)	(None, 32)	0
dense_10 (Dense)	(None, 16)	528
batch_normalization_8 (BatchNormalization)	(None, 16)	64
dropout_8 (Dropout)	(None, 16)	0
dense_11 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
265/265 3s 3ms/step - accuracy: 0.1330 - loss: 3.2178 - val_accuracy: 0.4090 - val_loss: 2.3290
Epoch 2/50
265/265 1s 2ms/step - accuracy: 0.3270 - loss: 2.3771 - val_accuracy: 0.4890 - val_loss: 1.9604
Epoch 3/50
265/265 1s 3ms/step - accuracy: 0.3883 - loss: 2.1360 - val_accuracy: 0.4960 - val_loss: 1.8188
Epoch 4/50
265/265 1s 2ms/step - accuracy: 0.4204 - loss: 2.0104 - val_accuracy: 0.5210 - val_loss: 1.7306
Epoch 5/50
265/265 1s 2ms/step - accuracy: 0.4348 - loss: 1.9300 - val_accuracy: 0.5170 - val_loss: 1.6821
Epoch 6/50
265/265 2s 4ms/step - accuracy: 0.4455 - loss: 1.8950 - val_accuracy: 0.5330 - val_loss: 1.6513
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.4511 - loss: 1.8444 - val_accuracy: 0.5260 - val_loss: 1.6071
Epoch 8/50
265/265 1s 4ms/step - accuracy: 0.4621 - loss: 1.8086 - val_accuracy: 0.5270 - val_loss: 1.5857
Epoch 9/50
265/265 1s 4ms/step - accuracy: 0.4553 - loss: 1.8177 - val_accuracy: 0.5370 - val_loss: 1.5689
Epoch 10/50
265/265 1s 3ms/step - accuracy: 0.4553 - loss: 1.7891 - val_accuracy: 0.5280 - val_loss: 1.5540
Epoch 11/50
265/265 1s 2ms/step - accuracy: 0.4604 - loss: 1.7859 - val_accuracy: 0.5540 - val_loss: 1.5334
Epoch 12/50
265/265 1s 3ms/step - accuracy: 0.4669 - loss: 1.7552 - val_accuracy: 0.5430 - val_loss: 1.5221
Epoch 13/50
265/265 1s 3ms/step - accuracy: 0.4656 - loss: 1.7527 - val_accuracy: 0.5530 - val_loss: 1.5139
Epoch 14/50
265/265 1s 3ms/step - accuracy: 0.4649 - loss: 1.7428 - val_accuracy: 0.5460 - val_loss: 1.5090
Epoch 15/50
265/265 1s 2ms/step - accuracy: 0.4748 - loss: 1.7247 - val_accuracy: 0.5480 - val_loss: 1.4965
Epoch 16/50
265/265 1s 3ms/step - accuracy: 0.4725 - loss: 1.7204 - val_accuracy: 0.5390 - val_loss: 1.4972
Epoch 17/50
265/265 1s 3ms/step - accuracy: 0.4782 - loss: 1.7045 - val_accuracy: 0.5380 - val_loss: 1.4918
Epoch 18/50
265/265 1s 2ms/step - accuracy: 0.4731 - loss: 1.7094 - val_accuracy: 0.5540 - val_loss: 1.4774
Epoch 19/50
265/265 1s 3ms/step - accuracy: 0.4710 - loss: 1.7225 - val_accuracy: 0.5510 - val_loss: 1.4662
Epoch 20/50
265/265 1s 3ms/step - accuracy: 0.4689 - loss: 1.7102 - val_accuracy: 0.5570 - val_loss: 1.4581
Epoch 21/50
265/265 1s 3ms/step - accuracy: 0.4781 - loss: 1.6768 - val_accuracy: 0.5420 - val_loss: 1.4507
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.4735 - loss: 1.6844 - val_accuracy: 0.5500 - val_loss: 1.4411
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.4788 - loss: 1.6824 - val_accuracy: 0.5520 - val_loss: 1.4449
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.4833 - loss: 1.6802 - val_accuracy: 0.5600 - val_loss: 1.4245
Epoch 25/50
265/265 1s 3ms/step - accuracy: 0.4822 - loss: 1.6659 - val_accuracy: 0.5610 - val_loss: 1.4250
Epoch 26/50
265/265 1s 3ms/step - accuracy: 0.4768 - loss: 1.6576 - val_accuracy: 0.5640 - val_loss: 1.4236
Epoch 27/50
265/265 1s 2ms/step - accuracy: 0.4828 - loss: 1.6707 - val_accuracy: 0.5700 - val_loss: 1.4179

```
Epoch 28/50
265/265 1s 2ms/step - accuracy: 0.4849 - loss: 1.6593 - val_accuracy: 0.5700 - val_loss: 1.4052
Epoch 29/50
265/265 1s 2ms/step - accuracy: 0.4842 - loss: 1.6417 - val_accuracy: 0.5510 - val_loss: 1.4167
Epoch 30/50
265/265 1s 3ms/step - accuracy: 0.4846 - loss: 1.6439 - val_accuracy: 0.5610 - val_loss: 1.4035
Epoch 31/50
265/265 1s 3ms/step - accuracy: 0.4920 - loss: 1.6309 - val_accuracy: 0.5630 - val_loss: 1.4013
Epoch 32/50
265/265 1s 3ms/step - accuracy: 0.4870 - loss: 1.6308 - val_accuracy: 0.5610 - val_loss: 1.4036
Epoch 33/50
265/265 1s 3ms/step - accuracy: 0.4891 - loss: 1.6228 - val_accuracy: 0.5720 - val_loss: 1.3845
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.4866 - loss: 1.6261 - val_accuracy: 0.5770 - val_loss: 1.3809
Epoch 35/50
265/265 1s 4ms/step - accuracy: 0.4884 - loss: 1.6234 - val_accuracy: 0.5560 - val_loss: 1.3918
Epoch 36/50
265/265 1s 4ms/step - accuracy: 0.4933 - loss: 1.6141 - val_accuracy: 0.5710 - val_loss: 1.3833
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.4831 - loss: 1.6337 - val_accuracy: 0.5520 - val_loss: 1.3998
Epoch 38/50
265/265 1s 3ms/step - accuracy: 0.4960 - loss: 1.6094 - val_accuracy: 0.5660 - val_loss: 1.3728
Epoch 39/50
265/265 1s 2ms/step - accuracy: 0.4953 - loss: 1.6209 - val_accuracy: 0.5660 - val_loss: 1.3729
Epoch 40/50
265/265 1s 3ms/step - accuracy: 0.4808 - loss: 1.6275 - val_accuracy: 0.5640 - val_loss: 1.3642
Epoch 41/50
265/265 1s 3ms/step - accuracy: 0.4952 - loss: 1.6183 - val_accuracy: 0.5470 - val_loss: 1.3667
Epoch 42/50
265/265 1s 3ms/step - accuracy: 0.4950 - loss: 1.6206 - val_accuracy: 0.5760 - val_loss: 1.3612
Epoch 43/50
265/265 1s 2ms/step - accuracy: 0.4958 - loss: 1.6092 - val_accuracy: 0.5690 - val_loss: 1.3635
Epoch 44/50
265/265 1s 3ms/step - accuracy: 0.5042 - loss: 1.5871 - val_accuracy: 0.5720 - val_loss: 1.3635
Epoch 45/50
265/265 1s 3ms/step - accuracy: 0.4946 - loss: 1.6098 - val_accuracy: 0.5590 - val_loss: 1.3606
Epoch 46/50
265/265 1s 3ms/step - accuracy: 0.4877 - loss: 1.6129 - val_accuracy: 0.5790 - val_loss: 1.3511
Epoch 47/50
265/265 1s 3ms/step - accuracy: 0.4984 - loss: 1.6004 - val_accuracy: 0.5810 - val_loss: 1.3463
Epoch 48/50
265/265 1s 3ms/step - accuracy: 0.4998 - loss: 1.5889 - val_accuracy: 0.5810 - val_loss: 1.3531
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.4948 - loss: 1.6043 - val_accuracy: 0.5720 - val_loss: 1.3563
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.4914 - loss: 1.6042 - val_accuracy: 0.5770 - val_loss: 1.3391
Accuracy: 0.5740
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_3"

Layer (type)	Output Shape	Param #
dense_12 (Dense)	(None, 64)	704
batch_normalization_9 (BatchNormalization)	(None, 64)	256
dropout_9 (Dropout)	(None, 64)	0
dense_13 (Dense)	(None, 32)	2,080
batch_normalization_10 (BatchNormalization)	(None, 32)	128
dropout_10 (Dropout)	(None, 32)	0
dense_14 (Dense)	(None, 16)	528
batch_normalization_11 (BatchNormalization)	(None, 16)	64
dropout_11 (Dropout)	(None, 16)	0
dense_15 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
265/265 4s 3ms/step - accuracy: 0.1321 - loss: 3.2469 - val_accuracy: 0.3780 - val_loss: 2.4257
Epoch 2/50
265/265 1s 3ms/step - accuracy: 0.2629 - loss: 2.5509 - val_accuracy: 0.4340 - val_loss: 2.0676
Epoch 3/50
265/265 1s 2ms/step - accuracy: 0.3331 - loss: 2.2959 - val_accuracy: 0.4610 - val_loss: 1.9115
Epoch 4/50
265/265 1s 3ms/step - accuracy: 0.3580 - loss: 2.1559 - val_accuracy: 0.4920 - val_loss: 1.8289
Epoch 5/50
265/265 1s 2ms/step - accuracy: 0.3758 - loss: 2.0828 - val_accuracy: 0.4990 - val_loss: 1.7672
Epoch 6/50
265/265 1s 3ms/step - accuracy: 0.3900 - loss: 2.0379 - val_accuracy: 0.5000 - val_loss: 1.7222
Epoch 7/50
265/265 1s 3ms/step - accuracy: 0.3987 - loss: 2.0096 - val_accuracy: 0.5030 - val_loss: 1.6888
Epoch 8/50
265/265 1s 2ms/step - accuracy: 0.4062 - loss: 1.9639 - val_accuracy: 0.5130 - val_loss: 1.6609
Epoch 9/50
265/265 1s 3ms/step - accuracy: 0.4056 - loss: 1.9541 - val_accuracy: 0.5020 - val_loss: 1.6477
Epoch 10/50
265/265 1s 3ms/step - accuracy: 0.4133 - loss: 1.9326 - val_accuracy: 0.5140 - val_loss: 1.6294
Epoch 11/50
265/265 1s 4ms/step - accuracy: 0.4168 - loss: 1.9105 - val_accuracy: 0.5120 - val_loss: 1.6104
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.4197 - loss: 1.8913 - val_accuracy: 0.5030 - val_loss: 1.6022
Epoch 13/50
265/265 1s 3ms/step - accuracy: 0.4214 - loss: 1.8872 - val_accuracy: 0.5050 - val_loss: 1.5913
Epoch 14/50
265/265 1s 2ms/step - accuracy: 0.4221 - loss: 1.8850 - val_accuracy: 0.5170 - val_loss: 1.5876
Epoch 15/50
265/265 1s 3ms/step - accuracy: 0.4270 - loss: 1.8487 - val_accuracy: 0.5230 - val_loss: 1.5713
Epoch 16/50
265/265 1s 2ms/step - accuracy: 0.4274 - loss: 1.8673 - val_accuracy: 0.5140 - val_loss: 1.5704
Epoch 17/50
265/265 1s 3ms/step - accuracy: 0.4320 - loss: 1.8458 - val_accuracy: 0.5230 - val_loss: 1.5452
Epoch 18/50
265/265 1s 2ms/step - accuracy: 0.4274 - loss: 1.8375 - val_accuracy: 0.5280 - val_loss: 1.5404
Epoch 19/50
265/265 1s 3ms/step - accuracy: 0.4306 - loss: 1.8365 - val_accuracy: 0.5270 - val_loss: 1.5300
Epoch 20/50
265/265 1s 2ms/step - accuracy: 0.4296 - loss: 1.8292 - val_accuracy: 0.5210 - val_loss: 1.5295
Epoch 21/50
265/265 1s 3ms/step - accuracy: 0.4334 - loss: 1.8222 - val_accuracy: 0.5290 - val_loss: 1.5324
Epoch 22/50
265/265 1s 2ms/step - accuracy: 0.4494 - loss: 1.8035 - val_accuracy: 0.5250 - val_loss: 1.5247
Epoch 23/50
265/265 2s 4ms/step - accuracy: 0.4444 - loss: 1.7854 - val_accuracy: 0.5400 - val_loss: 1.5097
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.4342 - loss: 1.8145 - val_accuracy: 0.5330 - val_loss: 1.5120
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.4408 - loss: 1.7850 - val_accuracy: 0.5270 - val_loss: 1.5164
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.4481 - loss: 1.7853 - val_accuracy: 0.5310 - val_loss: 1.5063
Epoch 27/50
265/265 1s 3ms/step - accuracy: 0.4446 - loss: 1.8027 - val_accuracy: 0.5320 - val_loss: 1.5063

```
Epoch 28/50
265/265 1s 3ms/step - accuracy: 0.4443 - loss: 1.7810 - val_accuracy: 0.5300 - val_loss: 1.4915
Epoch 29/50
265/265 1s 3ms/step - accuracy: 0.4455 - loss: 1.7710 - val_accuracy: 0.5400 - val_loss: 1.4843
Epoch 30/50
265/265 1s 2ms/step - accuracy: 0.4398 - loss: 1.7869 - val_accuracy: 0.5220 - val_loss: 1.4824
Epoch 31/50
265/265 1s 3ms/step - accuracy: 0.4384 - loss: 1.7782 - val_accuracy: 0.5310 - val_loss: 1.4874
Epoch 32/50
265/265 1s 3ms/step - accuracy: 0.4461 - loss: 1.7727 - val_accuracy: 0.5410 - val_loss: 1.4815
Epoch 33/50
265/265 1s 2ms/step - accuracy: 0.4421 - loss: 1.7720 - val_accuracy: 0.5360 - val_loss: 1.4760
Epoch 34/50
265/265 1s 3ms/step - accuracy: 0.4331 - loss: 1.7933 - val_accuracy: 0.5400 - val_loss: 1.4747
Epoch 35/50
265/265 1s 3ms/step - accuracy: 0.4587 - loss: 1.7503 - val_accuracy: 0.5460 - val_loss: 1.4786
Epoch 36/50
265/265 1s 2ms/step - accuracy: 0.4452 - loss: 1.7677 - val_accuracy: 0.5530 - val_loss: 1.4621
Epoch 37/50
265/265 2s 4ms/step - accuracy: 0.4505 - loss: 1.7620 - val_accuracy: 0.5450 - val_loss: 1.4660
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.4477 - loss: 1.7617 - val_accuracy: 0.5420 - val_loss: 1.4588
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.4484 - loss: 1.7487 - val_accuracy: 0.5510 - val_loss: 1.4569
Epoch 40/50
265/265 1s 5ms/step - accuracy: 0.4519 - loss: 1.7490 - val_accuracy: 0.5480 - val_loss: 1.4665
Epoch 41/50
265/265 2s 3ms/step - accuracy: 0.4412 - loss: 1.7628 - val_accuracy: 0.5460 - val_loss: 1.4589
Epoch 42/50
265/265 1s 2ms/step - accuracy: 0.4500 - loss: 1.7622 - val_accuracy: 0.5460 - val_loss: 1.4536
Epoch 43/50
265/265 1s 3ms/step - accuracy: 0.4501 - loss: 1.7409 - val_accuracy: 0.5530 - val_loss: 1.4578
Epoch 44/50
265/265 1s 3ms/step - accuracy: 0.4524 - loss: 1.7534 - val_accuracy: 0.5460 - val_loss: 1.4510
Epoch 45/50
265/265 1s 2ms/step - accuracy: 0.4539 - loss: 1.7401 - val_accuracy: 0.5440 - val_loss: 1.4539
Epoch 46/50
265/265 1s 2ms/step - accuracy: 0.4550 - loss: 1.7410 - val_accuracy: 0.5480 - val_loss: 1.4470
Epoch 47/50
265/265 1s 3ms/step - accuracy: 0.4438 - loss: 1.7625 - val_accuracy: 0.5510 - val_loss: 1.4402
Epoch 48/50
265/265 1s 3ms/step - accuracy: 0.4456 - loss: 1.7398 - val_accuracy: 0.5580 - val_loss: 1.4345
Epoch 49/50
265/265 2s 4ms/step - accuracy: 0.4487 - loss: 1.7463 - val_accuracy: 0.5470 - val_loss: 1.4404
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.4466 - loss: 1.7403 - val_accuracy: 0.5580 - val_loss: 1.4330
Accuracy: 0.5575
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_4"

Layer (type)	Output Shape	Param #
dense_16 (Dense)	(None, 64)	704
batch_normalization_12 (BatchNormalization)	(None, 64)	256
dropout_12 (Dropout)	(None, 64)	0
dense_17 (Dense)	(None, 32)	2,080
batch_normalization_13 (BatchNormalization)	(None, 32)	128
dropout_13 (Dropout)	(None, 32)	0
dense_18 (Dense)	(None, 16)	528
batch_normalization_14 (BatchNormalization)	(None, 16)	64
dropout_14 (Dropout)	(None, 16)	0
dense_19 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
530/530 6s 4ms/step - accuracy: 0.2960 - loss: 2.4303 - val_accuracy: 0.4610 - val_loss: 1.7796
Epoch 2/50
530/530 2s 4ms/step - accuracy: 0.4002 - loss: 1.9871 - val_accuracy: 0.4890 - val_loss: 1.6952
Epoch 3/50
530/530 2s 3ms/step - accuracy: 0.4160 - loss: 1.9398 - val_accuracy: 0.4970 - val_loss: 1.7294
Epoch 4/50
530/530 2s 3ms/step - accuracy: 0.4138 - loss: 1.9244 - val_accuracy: 0.4890 - val_loss: 1.6648
Epoch 5/50
530/530 2s 4ms/step - accuracy: 0.4153 - loss: 1.9200 - val_accuracy: 0.5170 - val_loss: 1.6206
Epoch 6/50
530/530 2s 4ms/step - accuracy: 0.4168 - loss: 1.8948 - val_accuracy: 0.5250 - val_loss: 1.6377
Epoch 7/50
530/530 1s 2ms/step - accuracy: 0.4193 - loss: 1.9140 - val_accuracy: 0.4990 - val_loss: 1.6517
Epoch 8/50
530/530 1s 2ms/step - accuracy: 0.4228 - loss: 1.8875 - val_accuracy: 0.4990 - val_loss: 1.6367
Epoch 9/50
530/530 3s 2ms/step - accuracy: 0.4222 - loss: 1.9084 - val_accuracy: 0.4980 - val_loss: 1.6685
Epoch 10/50
530/530 3s 2ms/step - accuracy: 0.4200 - loss: 1.8915 - val_accuracy: 0.4970 - val_loss: 1.6654
Epoch 11/50
530/530 3s 3ms/step - accuracy: 0.4210 - loss: 1.8821 - val_accuracy: 0.4890 - val_loss: 1.6480
Epoch 12/50
530/530 3s 4ms/step - accuracy: 0.4244 - loss: 1.8825 - val_accuracy: 0.5310 - val_loss: 1.6123
Epoch 13/50
530/530 1s 2ms/step - accuracy: 0.4274 - loss: 1.8678 - val_accuracy: 0.5130 - val_loss: 1.6472
Epoch 14/50
530/530 1s 2ms/step - accuracy: 0.4251 - loss: 1.9027 - val_accuracy: 0.4770 - val_loss: 1.6691
Epoch 15/50
530/530 1s 2ms/step - accuracy: 0.4207 - loss: 1.8835 - val_accuracy: 0.4890 - val_loss: 1.6514
Epoch 16/50
530/530 3s 2ms/step - accuracy: 0.4262 - loss: 1.8810 - val_accuracy: 0.4860 - val_loss: 1.6451
Epoch 17/50
530/530 3s 2ms/step - accuracy: 0.4302 - loss: 1.8831 - val_accuracy: 0.5320 - val_loss: 1.5786
Epoch 18/50
530/530 2s 3ms/step - accuracy: 0.4337 - loss: 1.8603 - val_accuracy: 0.5270 - val_loss: 1.6132
Epoch 19/50
530/530 2s 4ms/step - accuracy: 0.4285 - loss: 1.8727 - val_accuracy: 0.5250 - val_loss: 1.5805
Epoch 20/50
530/530 2s 4ms/step - accuracy: 0.4428 - loss: 1.8558 - val_accuracy: 0.5020 - val_loss: 1.6353
Epoch 21/50
530/530 2s 2ms/step - accuracy: 0.4344 - loss: 1.8764 - val_accuracy: 0.5230 - val_loss: 1.5871
Epoch 22/50
530/530 3s 2ms/step - accuracy: 0.4376 - loss: 1.8621 - val_accuracy: 0.5270 - val_loss: 1.6087
Epoch 23/50
530/530 3s 2ms/step - accuracy: 0.4290 - loss: 1.8836 - val_accuracy: 0.5080 - val_loss: 1.5986
Epoch 24/50
530/530 3s 2ms/step - accuracy: 0.4299 - loss: 1.8741 - val_accuracy: 0.5270 - val_loss: 1.6051
Epoch 25/50
530/530 3s 4ms/step - accuracy: 0.4405 - loss: 1.8539 - val_accuracy: 0.5210 - val_loss: 1.5784
Epoch 26/50
530/530 1s 2ms/step - accuracy: 0.4256 - loss: 1.8802 - val_accuracy: 0.5380 - val_loss: 1.5802
Epoch 27/50
530/530 1s 2ms/step - accuracy: 0.4430 - loss: 1.8545 - val_accuracy: 0.5270 - val_loss: 1.5673

```
Epoch 28/50
530/530 ━━━━━━ 3s 2ms/step - accuracy: 0.4346 - loss: 1.8681 - val_accuracy: 0.5170 - val_loss: 1.6192
Epoch 29/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4319 - loss: 1.8622 - val_accuracy: 0.4930 - val_loss: 1.6542
Epoch 30/50
530/530 ━━━━━━ 2s 2ms/step - accuracy: 0.4365 - loss: 1.8586 - val_accuracy: 0.5060 - val_loss: 1.6045
Epoch 31/50
530/530 ━━━━━━ 1s 3ms/step - accuracy: 0.4307 - loss: 1.8665 - val_accuracy: 0.5150 - val_loss: 1.6234
Epoch 32/50
530/530 ━━━━━━ 2s 3ms/step - accuracy: 0.4357 - loss: 1.8600 - val_accuracy: 0.5300 - val_loss: 1.5617
Epoch 33/50
530/530 ━━━━━━ 2s 3ms/step - accuracy: 0.4389 - loss: 1.8493 - val_accuracy: 0.5120 - val_loss: 1.5924
Epoch 34/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4331 - loss: 1.8691 - val_accuracy: 0.5350 - val_loss: 1.5728
Epoch 35/50
530/530 ━━━━━━ 3s 2ms/step - accuracy: 0.4388 - loss: 1.8474 - val_accuracy: 0.5120 - val_loss: 1.6230
Epoch 36/50
530/530 ━━━━━━ 1s 3ms/step - accuracy: 0.4386 - loss: 1.8559 - val_accuracy: 0.5170 - val_loss: 1.6093
Epoch 37/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4330 - loss: 1.8492 - val_accuracy: 0.5200 - val_loss: 1.5977
Epoch 38/50
530/530 ━━━━━━ 1s 3ms/step - accuracy: 0.4390 - loss: 1.8492 - val_accuracy: 0.5120 - val_loss: 1.5953
Epoch 39/50
530/530 ━━━━━━ 1s 3ms/step - accuracy: 0.4358 - loss: 1.8641 - val_accuracy: 0.4970 - val_loss: 1.6315
Epoch 40/50
530/530 ━━━━━━ 3s 4ms/step - accuracy: 0.4363 - loss: 1.8597 - val_accuracy: 0.5370 - val_loss: 1.5751
Epoch 41/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4408 - loss: 1.8399 - val_accuracy: 0.4970 - val_loss: 1.6133
Epoch 42/50
530/530 ━━━━━━ 3s 2ms/step - accuracy: 0.4321 - loss: 1.8583 - val_accuracy: 0.5270 - val_loss: 1.5741
Epoch 43/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4317 - loss: 1.8711 - val_accuracy: 0.5340 - val_loss: 1.5793
Epoch 44/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4368 - loss: 1.8700 - val_accuracy: 0.5160 - val_loss: 1.6095
Epoch 45/50
530/530 ━━━━━━ 3s 2ms/step - accuracy: 0.4326 - loss: 1.8657 - val_accuracy: 0.5210 - val_loss: 1.6202
Epoch 46/50
530/530 ━━━━━━ 3s 4ms/step - accuracy: 0.4345 - loss: 1.8540 - val_accuracy: 0.5140 - val_loss: 1.6128
Epoch 47/50
530/530 ━━━━━━ 2s 4ms/step - accuracy: 0.4370 - loss: 1.8544 - val_accuracy: 0.5180 - val_loss: 1.6212
Epoch 48/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4366 - loss: 1.8759 - val_accuracy: 0.5030 - val_loss: 1.6328
Epoch 49/50
530/530 ━━━━━━ 1s 3ms/step - accuracy: 0.4389 - loss: 1.8401 - val_accuracy: 0.5240 - val_loss: 1.6031
Epoch 50/50
530/530 ━━━━━━ 1s 2ms/step - accuracy: 0.4314 - loss: 1.8623 - val_accuracy: 0.5030 - val_loss: 1.6118
Accuracy: 0.5105
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_5"

Layer (type)	Output Shape	Param #
dense_20 (Dense)	(None, 64)	704
batch_normalization_15 (BatchNormalization)	(None, 64)	256
dropout_15 (Dropout)	(None, 64)	0
dense_21 (Dense)	(None, 32)	2,080
batch_normalization_16 (BatchNormalization)	(None, 32)	128
dropout_16 (Dropout)	(None, 32)	0
dense_22 (Dense)	(None, 16)	528
batch_normalization_17 (BatchNormalization)	(None, 16)	64
dropout_17 (Dropout)	(None, 16)	0
dense_23 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
530/530 4s 3ms/step - accuracy: 0.2662 - loss: 2.5647 - val_accuracy: 0.4310 - val_loss: 1.8320
Epoch 2/50
530/530 2s 4ms/step - accuracy: 0.3500 - loss: 2.1314 - val_accuracy: 0.4280 - val_loss: 1.8507
Epoch 3/50
530/530 2s 4ms/step - accuracy: 0.3705 - loss: 2.0805 - val_accuracy: 0.4560 - val_loss: 1.7507
Epoch 4/50
530/530 2s 2ms/step - accuracy: 0.3718 - loss: 2.0558 - val_accuracy: 0.4840 - val_loss: 1.7455
Epoch 5/50
530/530 3s 2ms/step - accuracy: 0.3754 - loss: 2.0628 - val_accuracy: 0.4960 - val_loss: 1.7070
Epoch 6/50
530/530 1s 3ms/step - accuracy: 0.3756 - loss: 2.0323 - val_accuracy: 0.4730 - val_loss: 1.7336
Epoch 7/50
530/530 2s 2ms/step - accuracy: 0.3851 - loss: 2.0199 - val_accuracy: 0.4820 - val_loss: 1.7362
Epoch 8/50
530/530 1s 3ms/step - accuracy: 0.3775 - loss: 2.0426 - val_accuracy: 0.5160 - val_loss: 1.7054
Epoch 9/50
530/530 3s 4ms/step - accuracy: 0.3878 - loss: 2.0331 - val_accuracy: 0.4860 - val_loss: 1.6992
Epoch 10/50
530/530 2s 2ms/step - accuracy: 0.3892 - loss: 2.0174 - val_accuracy: 0.4990 - val_loss: 1.7081
Epoch 11/50
530/530 2s 2ms/step - accuracy: 0.3909 - loss: 2.0093 - val_accuracy: 0.4920 - val_loss: 1.7218
Epoch 12/50
530/530 1s 2ms/step - accuracy: 0.3863 - loss: 2.0259 - val_accuracy: 0.4660 - val_loss: 1.7086
Epoch 13/50
530/530 1s 2ms/step - accuracy: 0.3962 - loss: 2.0203 - val_accuracy: 0.4890 - val_loss: 1.7173
Epoch 14/50
530/530 1s 2ms/step - accuracy: 0.3824 - loss: 2.0175 - val_accuracy: 0.4890 - val_loss: 1.7178
Epoch 15/50
530/530 1s 3ms/step - accuracy: 0.3947 - loss: 1.9986 - val_accuracy: 0.5050 - val_loss: 1.6976
Epoch 16/50
530/530 2s 3ms/step - accuracy: 0.3838 - loss: 2.0144 - val_accuracy: 0.4740 - val_loss: 1.7393
Epoch 17/50
530/530 2s 4ms/step - accuracy: 0.3890 - loss: 1.9974 - val_accuracy: 0.4780 - val_loss: 1.7004
Epoch 18/50
530/530 2s 4ms/step - accuracy: 0.3952 - loss: 2.0132 - val_accuracy: 0.4940 - val_loss: 1.6920
Epoch 19/50
530/530 2s 2ms/step - accuracy: 0.3898 - loss: 1.9981 - val_accuracy: 0.4860 - val_loss: 1.7040
Epoch 20/50
530/530 3s 2ms/step - accuracy: 0.3881 - loss: 2.0125 - val_accuracy: 0.4910 - val_loss: 1.7263
Epoch 21/50
530/530 1s 3ms/step - accuracy: 0.3982 - loss: 2.0094 - val_accuracy: 0.5090 - val_loss: 1.6587
Epoch 22/50
530/530 2s 2ms/step - accuracy: 0.4008 - loss: 1.9948 - val_accuracy: 0.4870 - val_loss: 1.6847
Epoch 23/50
530/530 1s 2ms/step - accuracy: 0.3911 - loss: 2.0252 - val_accuracy: 0.5030 - val_loss: 1.7210
Epoch 24/50
530/530 3s 4ms/step - accuracy: 0.3965 - loss: 1.9875 - val_accuracy: 0.4990 - val_loss: 1.6772
Epoch 25/50
530/530 2s 3ms/step - accuracy: 0.3931 - loss: 1.9990 - val_accuracy: 0.4800 - val_loss: 1.6822
Epoch 26/50
530/530 2s 2ms/step - accuracy: 0.3979 - loss: 1.9936 - val_accuracy: 0.4780 - val_loss: 1.7105
Epoch 27/50
530/530 1s 2ms/step - accuracy: 0.3856 - loss: 2.0248 - val_accuracy: 0.4820 - val_loss: 1.7218

```
Epoch 28/50
530/530 1s 3ms/step - accuracy: 0.3947 - loss: 2.0028 - val_accuracy: 0.4890 - val_loss: 1.6984
Epoch 29/50
530/530 1s 2ms/step - accuracy: 0.3895 - loss: 2.0024 - val_accuracy: 0.5130 - val_loss: 1.6451
Epoch 30/50
530/530 1s 2ms/step - accuracy: 0.3972 - loss: 2.0015 - val_accuracy: 0.4650 - val_loss: 1.7224
Epoch 31/50
530/530 3s 4ms/step - accuracy: 0.3984 - loss: 2.0145 - val_accuracy: 0.5110 - val_loss: 1.7016
Epoch 32/50
530/530 2s 4ms/step - accuracy: 0.3900 - loss: 2.0107 - val_accuracy: 0.4940 - val_loss: 1.7036
Epoch 33/50
530/530 2s 3ms/step - accuracy: 0.3921 - loss: 1.9900 - val_accuracy: 0.4920 - val_loss: 1.6804
Epoch 34/50
530/530 2s 2ms/step - accuracy: 0.3885 - loss: 1.9911 - val_accuracy: 0.4940 - val_loss: 1.6651
Epoch 35/50
530/530 1s 3ms/step - accuracy: 0.3993 - loss: 1.9817 - val_accuracy: 0.5080 - val_loss: 1.6413
Epoch 36/50
530/530 1s 3ms/step - accuracy: 0.3923 - loss: 1.9945 - val_accuracy: 0.5230 - val_loss: 1.6618
Epoch 37/50
530/530 1s 2ms/step - accuracy: 0.3929 - loss: 1.9941 - val_accuracy: 0.5010 - val_loss: 1.6818
Epoch 38/50
530/530 3s 3ms/step - accuracy: 0.4000 - loss: 1.9937 - val_accuracy: 0.4980 - val_loss: 1.7216
Epoch 39/50
530/530 3s 4ms/step - accuracy: 0.3970 - loss: 1.9859 - val_accuracy: 0.4940 - val_loss: 1.6734
Epoch 40/50
530/530 1s 3ms/step - accuracy: 0.3945 - loss: 1.9852 - val_accuracy: 0.5210 - val_loss: 1.7065
Epoch 41/50
530/530 1s 3ms/step - accuracy: 0.3945 - loss: 2.0101 - val_accuracy: 0.5040 - val_loss: 1.6726
Epoch 42/50
530/530 2s 2ms/step - accuracy: 0.4005 - loss: 1.9796 - val_accuracy: 0.4920 - val_loss: 1.7126
Epoch 43/50
530/530 3s 2ms/step - accuracy: 0.3907 - loss: 1.9951 - val_accuracy: 0.4840 - val_loss: 1.6818
Epoch 44/50
530/530 1s 2ms/step - accuracy: 0.3883 - loss: 2.0173 - val_accuracy: 0.4650 - val_loss: 1.7501
Epoch 45/50
530/530 3s 4ms/step - accuracy: 0.3930 - loss: 1.9896 - val_accuracy: 0.5070 - val_loss: 1.6844
Epoch 46/50
530/530 2s 2ms/step - accuracy: 0.3904 - loss: 2.0095 - val_accuracy: 0.4870 - val_loss: 1.6651
Epoch 47/50
530/530 1s 2ms/step - accuracy: 0.3953 - loss: 1.9893 - val_accuracy: 0.5060 - val_loss: 1.6908
Epoch 48/50
530/530 3s 3ms/step - accuracy: 0.3943 - loss: 2.0145 - val_accuracy: 0.5070 - val_loss: 1.6997
Epoch 49/50
530/530 3s 2ms/step - accuracy: 0.3966 - loss: 1.9958 - val_accuracy: 0.4950 - val_loss: 1.6919
Epoch 50/50
530/530 3s 3ms/step - accuracy: 0.3973 - loss: 1.9944 - val_accuracy: 0.5080 - val_loss: 1.6839
Accuracy: 0.4895
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_6"

Layer (type)	Output Shape	Param #
dense_24 (Dense)	(None, 64)	704
batch_normalization_18 (BatchNormalization)	(None, 64)	256
dropout_18 (Dropout)	(None, 64)	0
dense_25 (Dense)	(None, 32)	2,080
batch_normalization_19 (BatchNormalization)	(None, 32)	128
dropout_19 (Dropout)	(None, 32)	0
dense_26 (Dense)	(None, 16)	528
batch_normalization_20 (BatchNormalization)	(None, 16)	64
dropout_20 (Dropout)	(None, 16)	0
dense_27 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
265/265 - 4s 3ms/step - accuracy: 0.2959 - loss: 2.5100 - val_accuracy: 0.4170 - val_loss: 1.8895
Epoch 2/50
265/265 - 1s 3ms/step - accuracy: 0.4202 - loss: 1.9207 - val_accuracy: 0.4850 - val_loss: 1.6959
Epoch 3/50
265/265 - 1s 3ms/step - accuracy: 0.4188 - loss: 1.8881 - val_accuracy: 0.5030 - val_loss: 1.6485
Epoch 4/50
265/265 - 1s 3ms/step - accuracy: 0.4357 - loss: 1.8373 - val_accuracy: 0.5000 - val_loss: 1.6582
Epoch 5/50
265/265 - 1s 3ms/step - accuracy: 0.4315 - loss: 1.8362 - val_accuracy: 0.4820 - val_loss: 1.6730
Epoch 6/50
265/265 - 1s 3ms/step - accuracy: 0.4349 - loss: 1.8330 - val_accuracy: 0.4970 - val_loss: 1.6033
Epoch 7/50
265/265 - 1s 3ms/step - accuracy: 0.4369 - loss: 1.8288 - val_accuracy: 0.5090 - val_loss: 1.5762
Epoch 8/50
265/265 - 1s 3ms/step - accuracy: 0.4392 - loss: 1.8148 - val_accuracy: 0.5390 - val_loss: 1.5420
Epoch 9/50
265/265 - 1s 3ms/step - accuracy: 0.4479 - loss: 1.8119 - val_accuracy: 0.5180 - val_loss: 1.5817
Epoch 10/50
265/265 - 1s 3ms/step - accuracy: 0.4530 - loss: 1.7843 - val_accuracy: 0.5270 - val_loss: 1.5364
Epoch 11/50
265/265 - 2s 4ms/step - accuracy: 0.4589 - loss: 1.7790 - val_accuracy: 0.5360 - val_loss: 1.5645
Epoch 12/50
265/265 - 1s 4ms/step - accuracy: 0.4587 - loss: 1.7734 - val_accuracy: 0.5220 - val_loss: 1.5590
Epoch 13/50
265/265 - 1s 4ms/step - accuracy: 0.4521 - loss: 1.7784 - val_accuracy: 0.5190 - val_loss: 1.5762
Epoch 14/50
265/265 - 1s 3ms/step - accuracy: 0.4584 - loss: 1.7632 - val_accuracy: 0.5490 - val_loss: 1.5429
Epoch 15/50
265/265 - 1s 3ms/step - accuracy: 0.4463 - loss: 1.7941 - val_accuracy: 0.5330 - val_loss: 1.5595
Epoch 16/50
265/265 - 1s 3ms/step - accuracy: 0.4554 - loss: 1.7747 - val_accuracy: 0.5320 - val_loss: 1.5884
Epoch 17/50
265/265 - 1s 3ms/step - accuracy: 0.4496 - loss: 1.7783 - val_accuracy: 0.5290 - val_loss: 1.5280
Epoch 18/50
265/265 - 1s 3ms/step - accuracy: 0.4540 - loss: 1.7723 - val_accuracy: 0.5450 - val_loss: 1.5112
Epoch 19/50
265/265 - 1s 3ms/step - accuracy: 0.4555 - loss: 1.7875 - val_accuracy: 0.5370 - val_loss: 1.5277
Epoch 20/50
265/265 - 1s 3ms/step - accuracy: 0.4553 - loss: 1.7741 - val_accuracy: 0.5440 - val_loss: 1.5463
Epoch 21/50
265/265 - 1s 3ms/step - accuracy: 0.4618 - loss: 1.7533 - val_accuracy: 0.5240 - val_loss: 1.5324
Epoch 22/50
265/265 - 1s 3ms/step - accuracy: 0.4576 - loss: 1.7827 - val_accuracy: 0.5450 - val_loss: 1.5042
Epoch 23/50
265/265 - 1s 3ms/step - accuracy: 0.4671 - loss: 1.7556 - val_accuracy: 0.5170 - val_loss: 1.5673
Epoch 24/50
265/265 - 1s 4ms/step - accuracy: 0.4563 - loss: 1.7657 - val_accuracy: 0.5290 - val_loss: 1.5146
Epoch 25/50
265/265 - 1s 4ms/step - accuracy: 0.4481 - loss: 1.7855 - val_accuracy: 0.5120 - val_loss: 1.5600
Epoch 26/50
265/265 - 1s 4ms/step - accuracy: 0.4623 - loss: 1.7676 - val_accuracy: 0.5480 - val_loss: 1.5034
Epoch 27/50
265/265 - 1s 3ms/step - accuracy: 0.4663 - loss: 1.7533 - val_accuracy: 0.5460 - val_loss: 1.4818

```
Epoch 28/50
265/265 1s 3ms/step - accuracy: 0.4565 - loss: 1.7714 - val_accuracy: 0.5290 - val_loss: 1.5472
Epoch 29/50
265/265 1s 3ms/step - accuracy: 0.4675 - loss: 1.7543 - val_accuracy: 0.5420 - val_loss: 1.5002
Epoch 30/50
265/265 1s 3ms/step - accuracy: 0.4681 - loss: 1.7590 - val_accuracy: 0.5110 - val_loss: 1.5577
Epoch 31/50
265/265 1s 3ms/step - accuracy: 0.4502 - loss: 1.7818 - val_accuracy: 0.5350 - val_loss: 1.5388
Epoch 32/50
265/265 1s 3ms/step - accuracy: 0.4432 - loss: 1.7951 - val_accuracy: 0.5200 - val_loss: 1.5108
Epoch 33/50
265/265 1s 3ms/step - accuracy: 0.4537 - loss: 1.7731 - val_accuracy: 0.5220 - val_loss: 1.5441
Epoch 34/50
265/265 1s 3ms/step - accuracy: 0.4663 - loss: 1.7541 - val_accuracy: 0.5100 - val_loss: 1.5364
Epoch 35/50
265/265 1s 3ms/step - accuracy: 0.4560 - loss: 1.7652 - val_accuracy: 0.5530 - val_loss: 1.4796
Epoch 36/50
265/265 1s 3ms/step - accuracy: 0.4624 - loss: 1.7579 - val_accuracy: 0.5070 - val_loss: 1.5158
Epoch 37/50
265/265 2s 4ms/step - accuracy: 0.4646 - loss: 1.7538 - val_accuracy: 0.4910 - val_loss: 1.5910
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.4640 - loss: 1.7649 - val_accuracy: 0.5590 - val_loss: 1.5076
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.4623 - loss: 1.7576 - val_accuracy: 0.5380 - val_loss: 1.4935
Epoch 40/50
265/265 1s 4ms/step - accuracy: 0.4739 - loss: 1.7382 - val_accuracy: 0.5300 - val_loss: 1.5044
Epoch 41/50
265/265 1s 3ms/step - accuracy: 0.4650 - loss: 1.7481 - val_accuracy: 0.5450 - val_loss: 1.4849
Epoch 42/50
265/265 1s 3ms/step - accuracy: 0.4579 - loss: 1.7694 - val_accuracy: 0.5400 - val_loss: 1.4992
Epoch 43/50
265/265 1s 3ms/step - accuracy: 0.4674 - loss: 1.7492 - val_accuracy: 0.5140 - val_loss: 1.5247
Epoch 44/50
265/265 1s 3ms/step - accuracy: 0.4666 - loss: 1.7430 - val_accuracy: 0.5150 - val_loss: 1.5679
Epoch 45/50
265/265 1s 3ms/step - accuracy: 0.4601 - loss: 1.7481 - val_accuracy: 0.5390 - val_loss: 1.5184
Epoch 46/50
265/265 1s 3ms/step - accuracy: 0.4726 - loss: 1.7247 - val_accuracy: 0.5090 - val_loss: 1.5677
Epoch 47/50
265/265 1s 3ms/step - accuracy: 0.4615 - loss: 1.7633 - val_accuracy: 0.5460 - val_loss: 1.5015
Epoch 48/50
265/265 1s 3ms/step - accuracy: 0.4694 - loss: 1.7291 - val_accuracy: 0.5020 - val_loss: 1.5227
Epoch 49/50
265/265 1s 3ms/step - accuracy: 0.4612 - loss: 1.7581 - val_accuracy: 0.5370 - val_loss: 1.5156
Epoch 50/50
265/265 1s 3ms/step - accuracy: 0.4687 - loss: 1.7430 - val_accuracy: 0.5120 - val_loss: 1.5367
Accuracy: 0.5295
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_7"

Layer (type)	Output Shape	Param #
dense_28 (Dense)	(None, 64)	704
batch_normalization_21 (BatchNormalization)	(None, 64)	256
dropout_21 (Dropout)	(None, 64)	0
dense_29 (Dense)	(None, 32)	2,080
batch_normalization_22 (BatchNormalization)	(None, 32)	128
dropout_22 (Dropout)	(None, 32)	0
dense_30 (Dense)	(None, 16)	528
batch_normalization_23 (BatchNormalization)	(None, 16)	64
dropout_23 (Dropout)	(None, 16)	0
dense_31 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
265/265 5s 5ms/step - accuracy: 0.2590 - loss: 2.5867 - val_accuracy: 0.4050 - val_loss: 2.0441
Epoch 2/50
265/265 2s 3ms/step - accuracy: 0.3693 - loss: 2.0626 - val_accuracy: 0.4590 - val_loss: 1.7887
Epoch 3/50
265/265 1s 3ms/step - accuracy: 0.3900 - loss: 1.9966 - val_accuracy: 0.4670 - val_loss: 1.7061
Epoch 4/50
265/265 1s 3ms/step - accuracy: 0.3834 - loss: 1.9814 - val_accuracy: 0.4730 - val_loss: 1.7064
Epoch 5/50
265/265 1s 3ms/step - accuracy: 0.3984 - loss: 1.9594 - val_accuracy: 0.4820 - val_loss: 1.6895
Epoch 6/50
265/265 1s 3ms/step - accuracy: 0.3962 - loss: 1.9577 - val_accuracy: 0.4920 - val_loss: 1.7058
Epoch 7/50
265/265 1s 3ms/step - accuracy: 0.4008 - loss: 1.9580 - val_accuracy: 0.4890 - val_loss: 1.6260
Epoch 8/50
265/265 1s 3ms/step - accuracy: 0.3981 - loss: 1.9451 - val_accuracy: 0.4910 - val_loss: 1.6575
Epoch 9/50
265/265 1s 3ms/step - accuracy: 0.4024 - loss: 1.9526 - val_accuracy: 0.4380 - val_loss: 1.7291
Epoch 10/50
265/265 1s 3ms/step - accuracy: 0.4036 - loss: 1.9378 - val_accuracy: 0.4930 - val_loss: 1.6519
Epoch 11/50
265/265 1s 3ms/step - accuracy: 0.4054 - loss: 1.9372 - val_accuracy: 0.5140 - val_loss: 1.6350
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.4104 - loss: 1.9229 - val_accuracy: 0.5000 - val_loss: 1.6164
Epoch 13/50
265/265 1s 4ms/step - accuracy: 0.4019 - loss: 1.9171 - val_accuracy: 0.4910 - val_loss: 1.6210
Epoch 14/50
265/265 1s 4ms/step - accuracy: 0.4080 - loss: 1.9232 - val_accuracy: 0.5120 - val_loss: 1.6035
Epoch 15/50
265/265 1s 3ms/step - accuracy: 0.4048 - loss: 1.9307 - val_accuracy: 0.4960 - val_loss: 1.6991
Epoch 16/50
265/265 1s 3ms/step - accuracy: 0.4033 - loss: 1.9314 - val_accuracy: 0.4990 - val_loss: 1.6297
Epoch 17/50
265/265 1s 3ms/step - accuracy: 0.4088 - loss: 1.9037 - val_accuracy: 0.5220 - val_loss: 1.5954
Epoch 18/50
265/265 1s 3ms/step - accuracy: 0.4068 - loss: 1.9296 - val_accuracy: 0.5080 - val_loss: 1.6095
Epoch 19/50
265/265 1s 3ms/step - accuracy: 0.4151 - loss: 1.8988 - val_accuracy: 0.5210 - val_loss: 1.5895
Epoch 20/50
265/265 1s 3ms/step - accuracy: 0.4056 - loss: 1.9128 - val_accuracy: 0.5040 - val_loss: 1.6264
Epoch 21/50
265/265 1s 3ms/step - accuracy: 0.4145 - loss: 1.9127 - val_accuracy: 0.5240 - val_loss: 1.6007
Epoch 22/50
265/265 1s 3ms/step - accuracy: 0.4163 - loss: 1.9119 - val_accuracy: 0.4920 - val_loss: 1.6337
Epoch 23/50
265/265 1s 3ms/step - accuracy: 0.4116 - loss: 1.9290 - val_accuracy: 0.5230 - val_loss: 1.6097
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.4149 - loss: 1.9039 - val_accuracy: 0.4930 - val_loss: 1.6562
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.4133 - loss: 1.9055 - val_accuracy: 0.5000 - val_loss: 1.6514
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.4065 - loss: 1.9166 - val_accuracy: 0.5310 - val_loss: 1.6179
Epoch 27/50
265/265 1s 4ms/step - accuracy: 0.4167 - loss: 1.9027 - val_accuracy: 0.5170 - val_loss: 1.6047

```
Epoch 28/50
265/265 1s 3ms/step - accuracy: 0.4191 - loss: 1.8923 - val_accuracy: 0.4950 - val_loss: 1.6427
Epoch 29/50
265/265 1s 3ms/step - accuracy: 0.4260 - loss: 1.8936 - val_accuracy: 0.5360 - val_loss: 1.5807
Epoch 30/50
265/265 1s 3ms/step - accuracy: 0.4214 - loss: 1.8883 - val_accuracy: 0.4870 - val_loss: 1.6226
Epoch 31/50
265/265 1s 3ms/step - accuracy: 0.4122 - loss: 1.9045 - val_accuracy: 0.4820 - val_loss: 1.6275
Epoch 32/50
265/265 1s 3ms/step - accuracy: 0.4200 - loss: 1.8908 - val_accuracy: 0.5160 - val_loss: 1.6097
Epoch 33/50
265/265 1s 3ms/step - accuracy: 0.4245 - loss: 1.8887 - val_accuracy: 0.5150 - val_loss: 1.6086
Epoch 34/50
265/265 1s 3ms/step - accuracy: 0.4218 - loss: 1.8991 - val_accuracy: 0.5180 - val_loss: 1.6017
Epoch 35/50
265/265 1s 3ms/step - accuracy: 0.4156 - loss: 1.9032 - val_accuracy: 0.4920 - val_loss: 1.6002
Epoch 36/50
265/265 1s 3ms/step - accuracy: 0.4100 - loss: 1.9120 - val_accuracy: 0.5210 - val_loss: 1.6285
Epoch 37/50
265/265 2s 4ms/step - accuracy: 0.4154 - loss: 1.9272 - val_accuracy: 0.5210 - val_loss: 1.6133
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.4223 - loss: 1.8804 - val_accuracy: 0.5240 - val_loss: 1.5875
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.4080 - loss: 1.9080 - val_accuracy: 0.5190 - val_loss: 1.6043
Epoch 40/50
265/265 1s 3ms/step - accuracy: 0.4239 - loss: 1.8985 - val_accuracy: 0.5360 - val_loss: 1.5904
Epoch 41/50
265/265 1s 3ms/step - accuracy: 0.4240 - loss: 1.8936 - val_accuracy: 0.5050 - val_loss: 1.6198
Epoch 42/50
265/265 1s 3ms/step - accuracy: 0.4159 - loss: 1.9029 - val_accuracy: 0.4840 - val_loss: 1.5993
Epoch 43/50
265/265 1s 3ms/step - accuracy: 0.4223 - loss: 1.8841 - val_accuracy: 0.5010 - val_loss: 1.5878
Epoch 44/50
265/265 1s 3ms/step - accuracy: 0.4232 - loss: 1.8830 - val_accuracy: 0.4890 - val_loss: 1.6258
Epoch 45/50
265/265 1s 3ms/step - accuracy: 0.4096 - loss: 1.9054 - val_accuracy: 0.5040 - val_loss: 1.5890
Epoch 46/50
265/265 1s 3ms/step - accuracy: 0.4080 - loss: 1.9030 - val_accuracy: 0.4970 - val_loss: 1.6115
Epoch 47/50
265/265 1s 3ms/step - accuracy: 0.4189 - loss: 1.8891 - val_accuracy: 0.5300 - val_loss: 1.5671
Epoch 48/50
265/265 1s 3ms/step - accuracy: 0.4173 - loss: 1.8966 - val_accuracy: 0.5020 - val_loss: 1.6187
Epoch 49/50
265/265 2s 4ms/step - accuracy: 0.4197 - loss: 1.8844 - val_accuracy: 0.5100 - val_loss: 1.5936
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.4208 - loss: 1.8682 - val_accuracy: 0.5110 - val_loss: 1.6067
Accuracy: 0.5050
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_8"

Layer (type)	Output Shape	Param #
dense_32 (Dense)	(None, 64)	704
batch_normalization_24 (BatchNormalization)	(None, 64)	256
dropout_24 (Dropout)	(None, 64)	0
dense_33 (Dense)	(None, 32)	2,080
batch_normalization_25 (BatchNormalization)	(None, 32)	128
dropout_25 (Dropout)	(None, 32)	0
dense_34 (Dense)	(None, 16)	528
batch_normalization_26 (BatchNormalization)	(None, 16)	64
dropout_26 (Dropout)	(None, 16)	0
dense_35 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
530/530 4s 3ms/step - accuracy: 0.2039 - loss: 2.8946 - val_accuracy: 0.2780 - val_loss: 2.4542
Epoch 2/50
530/530 1s 3ms/step - accuracy: 0.2376 - loss: 2.6955 - val_accuracy: 0.2610 - val_loss: 2.5933
Epoch 3/50
530/530 1s 3ms/step - accuracy: 0.2367 - loss: 2.6850 - val_accuracy: 0.2730 - val_loss: 2.5700
Epoch 4/50
530/530 3s 3ms/step - accuracy: 0.2466 - loss: 2.6887 - val_accuracy: 0.3140 - val_loss: 2.4853
Epoch 5/50
530/530 3s 4ms/step - accuracy: 0.2541 - loss: 2.7061 - val_accuracy: 0.2380 - val_loss: 2.7066
Epoch 6/50
530/530 2s 4ms/step - accuracy: 0.2570 - loss: 2.6809 - val_accuracy: 0.2870 - val_loss: 2.4605
Epoch 7/50
530/530 2s 3ms/step - accuracy: 0.2635 - loss: 2.6425 - val_accuracy: 0.3010 - val_loss: 2.5495
Epoch 8/50
530/530 1s 3ms/step - accuracy: 0.2601 - loss: 2.6665 - val_accuracy: 0.2680 - val_loss: 2.5816
Epoch 9/50
530/530 1s 2ms/step - accuracy: 0.2660 - loss: 2.6405 - val_accuracy: 0.2790 - val_loss: 2.5599
Epoch 10/50
530/530 1s 3ms/step - accuracy: 0.2720 - loss: 2.6438 - val_accuracy: 0.3310 - val_loss: 2.4081
Epoch 11/50
530/530 3s 3ms/step - accuracy: 0.2639 - loss: 2.6573 - val_accuracy: 0.3290 - val_loss: 2.3469
Epoch 12/50
530/530 1s 3ms/step - accuracy: 0.2666 - loss: 2.6371 - val_accuracy: 0.3070 - val_loss: 2.5017
Epoch 13/50
530/530 3s 3ms/step - accuracy: 0.2621 - loss: 2.6546 - val_accuracy: 0.3270 - val_loss: 2.4571
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.2715 - loss: 2.6172 - val_accuracy: 0.3410 - val_loss: 2.4183
Epoch 15/50
530/530 3s 3ms/step - accuracy: 0.2831 - loss: 2.6189 - val_accuracy: 0.3260 - val_loss: 2.3576
Epoch 16/50
530/530 1s 3ms/step - accuracy: 0.2784 - loss: 2.6186 - val_accuracy: 0.2490 - val_loss: 2.4451
Epoch 17/50
530/530 2s 3ms/step - accuracy: 0.2730 - loss: 2.6097 - val_accuracy: 0.2790 - val_loss: 2.6806
Epoch 18/50
530/530 3s 3ms/step - accuracy: 0.2734 - loss: 2.6409 - val_accuracy: 0.2650 - val_loss: 2.5940
Epoch 19/50
530/530 3s 4ms/step - accuracy: 0.2729 - loss: 2.6537 - val_accuracy: 0.2710 - val_loss: 2.6608
Epoch 20/50
530/530 1s 3ms/step - accuracy: 0.2658 - loss: 2.6364 - val_accuracy: 0.3540 - val_loss: 2.4057
Epoch 21/50
530/530 1s 3ms/step - accuracy: 0.2808 - loss: 2.6096 - val_accuracy: 0.2840 - val_loss: 2.4585
Epoch 22/50
530/530 3s 3ms/step - accuracy: 0.2763 - loss: 2.6293 - val_accuracy: 0.3110 - val_loss: 2.4058
Epoch 23/50
530/530 1s 3ms/step - accuracy: 0.2689 - loss: 2.6483 - val_accuracy: 0.3380 - val_loss: 2.4972
Epoch 24/50
530/530 1s 3ms/step - accuracy: 0.2746 - loss: 2.6307 - val_accuracy: 0.2700 - val_loss: 2.4531
Epoch 25/50
530/530 3s 3ms/step - accuracy: 0.2667 - loss: 2.6401 - val_accuracy: 0.3020 - val_loss: 2.4772
Epoch 26/50
530/530 2s 4ms/step - accuracy: 0.2719 - loss: 2.6404 - val_accuracy: 0.2620 - val_loss: 2.4850
Epoch 27/50
530/530 2s 3ms/step - accuracy: 0.2751 - loss: 2.6128 - val_accuracy: 0.2850 - val_loss: 2.4983

```
Epoch 28/50
530/530 3s 3ms/step - accuracy: 0.2796 - loss: 2.6179 - val_accuracy: 0.3300 - val_loss: 2.4257
Epoch 29/50
530/530 3s 3ms/step - accuracy: 0.2702 - loss: 2.6309 - val_accuracy: 0.3860 - val_loss: 2.3137
Epoch 30/50
530/530 1s 3ms/step - accuracy: 0.2794 - loss: 2.6202 - val_accuracy: 0.2240 - val_loss: 2.7486
Epoch 31/50
530/530 1s 3ms/step - accuracy: 0.2867 - loss: 2.6378 - val_accuracy: 0.3320 - val_loss: 2.5236
Epoch 32/50
530/530 2s 3ms/step - accuracy: 0.2854 - loss: 2.6037 - val_accuracy: 0.2800 - val_loss: 2.4323
Epoch 33/50
530/530 2s 4ms/step - accuracy: 0.2687 - loss: 2.6364 - val_accuracy: 0.2610 - val_loss: 2.4245
Epoch 34/50
530/530 2s 4ms/step - accuracy: 0.2721 - loss: 2.6090 - val_accuracy: 0.3200 - val_loss: 2.4318
Epoch 35/50
530/530 2s 2ms/step - accuracy: 0.2786 - loss: 2.6239 - val_accuracy: 0.3380 - val_loss: 2.4154
Epoch 36/50
530/530 1s 3ms/step - accuracy: 0.2850 - loss: 2.5868 - val_accuracy: 0.3860 - val_loss: 2.2973
Epoch 37/50
530/530 3s 3ms/step - accuracy: 0.2760 - loss: 2.6239 - val_accuracy: 0.3970 - val_loss: 2.2532
Epoch 38/50
530/530 3s 3ms/step - accuracy: 0.2692 - loss: 2.6429 - val_accuracy: 0.2520 - val_loss: 2.5514
Epoch 39/50
530/530 1s 2ms/step - accuracy: 0.2736 - loss: 2.6444 - val_accuracy: 0.3460 - val_loss: 2.4039
Epoch 40/50
530/530 3s 4ms/step - accuracy: 0.2730 - loss: 2.6402 - val_accuracy: 0.2990 - val_loss: 2.5381
Epoch 41/50
530/530 1s 3ms/step - accuracy: 0.2849 - loss: 2.5955 - val_accuracy: 0.3140 - val_loss: 2.6130
Epoch 42/50
530/530 1s 2ms/step - accuracy: 0.2730 - loss: 2.6241 - val_accuracy: 0.3020 - val_loss: 2.5193
Epoch 43/50
530/530 3s 3ms/step - accuracy: 0.2736 - loss: 2.6160 - val_accuracy: 0.3520 - val_loss: 2.2877
Epoch 44/50
530/530 2s 2ms/step - accuracy: 0.2743 - loss: 2.6031 - val_accuracy: 0.3240 - val_loss: 2.5387
Epoch 45/50
530/530 3s 3ms/step - accuracy: 0.2710 - loss: 2.6466 - val_accuracy: 0.3540 - val_loss: 2.3695
Epoch 46/50
530/530 2s 4ms/step - accuracy: 0.2649 - loss: 2.6508 - val_accuracy: 0.3480 - val_loss: 2.4364
Epoch 47/50
530/530 2s 3ms/step - accuracy: 0.2749 - loss: 2.6355 - val_accuracy: 0.3600 - val_loss: 2.4095
Epoch 48/50
530/530 2s 2ms/step - accuracy: 0.2833 - loss: 2.6267 - val_accuracy: 0.3500 - val_loss: 2.3756
Epoch 49/50
530/530 1s 3ms/step - accuracy: 0.2860 - loss: 2.6080 - val_accuracy: 0.3500 - val_loss: 2.3556
Epoch 50/50
530/530 3s 3ms/step - accuracy: 0.2812 - loss: 2.6059 - val_accuracy: 0.3030 - val_loss: 2.6480
Accuracy: 0.2965
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_9"

Layer (type)	Output Shape	Param #
dense_36 (Dense)	(None, 64)	704
batch_normalization_27 (BatchNormalization)	(None, 64)	256
dropout_27 (Dropout)	(None, 64)	0
dense_37 (Dense)	(None, 32)	2,080
batch_normalization_28 (BatchNormalization)	(None, 32)	128
dropout_28 (Dropout)	(None, 32)	0
dense_38 (Dense)	(None, 16)	528
batch_normalization_29 (BatchNormalization)	(None, 16)	64
dropout_29 (Dropout)	(None, 16)	0
dense_39 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
530/530 6s 5ms/step - accuracy: 0.1874 - loss: 2.9843 - val_accuracy: 0.2540 - val_loss: 2.4878
Epoch 2/50
530/530 1s 3ms/step - accuracy: 0.1921 - loss: 2.8272 - val_accuracy: 0.2740 - val_loss: 2.5103
Epoch 3/50
530/530 1s 3ms/step - accuracy: 0.2117 - loss: 2.8117 - val_accuracy: 0.2860 - val_loss: 2.4389
Epoch 4/50
530/530 3s 3ms/step - accuracy: 0.2148 - loss: 2.7919 - val_accuracy: 0.2670 - val_loss: 2.6379
Epoch 5/50
530/530 3s 3ms/step - accuracy: 0.2127 - loss: 2.7952 - val_accuracy: 0.1860 - val_loss: 2.7019
Epoch 6/50
530/530 1s 3ms/step - accuracy: 0.2114 - loss: 2.8068 - val_accuracy: 0.2790 - val_loss: 2.5248
Epoch 7/50
530/530 2s 3ms/step - accuracy: 0.2146 - loss: 2.8101 - val_accuracy: 0.2340 - val_loss: 2.6990
Epoch 8/50
530/530 2s 4ms/step - accuracy: 0.2150 - loss: 2.7975 - val_accuracy: 0.2640 - val_loss: 2.7727
Epoch 9/50
530/530 2s 3ms/step - accuracy: 0.2264 - loss: 2.7663 - val_accuracy: 0.2780 - val_loss: 2.5478
Epoch 10/50
530/530 2s 3ms/step - accuracy: 0.2220 - loss: 2.7746 - val_accuracy: 0.2600 - val_loss: 2.6255
Epoch 11/50
530/530 3s 3ms/step - accuracy: 0.2190 - loss: 2.7971 - val_accuracy: 0.2740 - val_loss: 2.5771
Epoch 12/50
530/530 3s 3ms/step - accuracy: 0.2270 - loss: 2.7578 - val_accuracy: 0.2410 - val_loss: 2.6736
Epoch 13/50
530/530 3s 4ms/step - accuracy: 0.2170 - loss: 2.7996 - val_accuracy: 0.2700 - val_loss: 2.6077
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.2269 - loss: 2.7889 - val_accuracy: 0.2100 - val_loss: 2.6570
Epoch 15/50
530/530 1s 3ms/step - accuracy: 0.2273 - loss: 2.7837 - val_accuracy: 0.2270 - val_loss: 2.7814
Epoch 16/50
530/530 3s 2ms/step - accuracy: 0.2224 - loss: 2.7825 - val_accuracy: 0.2730 - val_loss: 2.5719
Epoch 17/50
530/530 1s 3ms/step - accuracy: 0.2332 - loss: 2.7713 - val_accuracy: 0.2370 - val_loss: 2.6690
Epoch 18/50
530/530 3s 3ms/step - accuracy: 0.2337 - loss: 2.7759 - val_accuracy: 0.2980 - val_loss: 2.6052
Epoch 19/50
530/530 3s 3ms/step - accuracy: 0.2304 - loss: 2.7737 - val_accuracy: 0.3100 - val_loss: 2.5453
Epoch 20/50
530/530 2s 4ms/step - accuracy: 0.2343 - loss: 2.7609 - val_accuracy: 0.2950 - val_loss: 2.4627
Epoch 21/50
530/530 2s 4ms/step - accuracy: 0.2361 - loss: 2.7457 - val_accuracy: 0.2890 - val_loss: 2.6032
Epoch 22/50
530/530 2s 2ms/step - accuracy: 0.2380 - loss: 2.7695 - val_accuracy: 0.2570 - val_loss: 2.6267
Epoch 23/50
530/530 3s 2ms/step - accuracy: 0.2277 - loss: 2.7733 - val_accuracy: 0.3180 - val_loss: 2.5219
Epoch 24/50
530/530 1s 2ms/step - accuracy: 0.2371 - loss: 2.7505 - val_accuracy: 0.2210 - val_loss: 2.9500
Epoch 25/50
530/530 1s 3ms/step - accuracy: 0.2274 - loss: 2.7820 - val_accuracy: 0.3210 - val_loss: 2.4746
Epoch 26/50
530/530 2s 2ms/step - accuracy: 0.2380 - loss: 2.7490 - val_accuracy: 0.2820 - val_loss: 2.7082
Epoch 27/50
530/530 2s 4ms/step - accuracy: 0.2336 - loss: 2.7668 - val_accuracy: 0.2680 - val_loss: 2.5925

```
Epoch 28/50
530/530 3s 4ms/step - accuracy: 0.2340 - loss: 2.7508 - val_accuracy: 0.2710 - val_loss: 2.7224
Epoch 29/50
530/530 2s 2ms/step - accuracy: 0.2322 - loss: 2.7693 - val_accuracy: 0.3750 - val_loss: 2.4601
Epoch 30/50
530/530 1s 3ms/step - accuracy: 0.2296 - loss: 2.7801 - val_accuracy: 0.2500 - val_loss: 2.5642
Epoch 31/50
530/530 3s 3ms/step - accuracy: 0.2272 - loss: 2.7879 - val_accuracy: 0.2950 - val_loss: 2.5988
Epoch 32/50
530/530 1s 3ms/step - accuracy: 0.2397 - loss: 2.7578 - val_accuracy: 0.3140 - val_loss: 2.5654
Epoch 33/50
530/530 3s 3ms/step - accuracy: 0.2386 - loss: 2.7637 - val_accuracy: 0.2490 - val_loss: 2.6134
Epoch 34/50
530/530 2s 4ms/step - accuracy: 0.2326 - loss: 2.7586 - val_accuracy: 0.3070 - val_loss: 2.5028
Epoch 35/50
530/530 2s 4ms/step - accuracy: 0.2404 - loss: 2.7518 - val_accuracy: 0.2660 - val_loss: 2.5248
Epoch 36/50
530/530 2s 3ms/step - accuracy: 0.2243 - loss: 2.7916 - val_accuracy: 0.3150 - val_loss: 2.4228
Epoch 37/50
530/530 2s 2ms/step - accuracy: 0.2457 - loss: 2.7281 - val_accuracy: 0.2730 - val_loss: 2.6005
Epoch 38/50
530/530 3s 3ms/step - accuracy: 0.2273 - loss: 2.7750 - val_accuracy: 0.3110 - val_loss: 2.5181
Epoch 39/50
530/530 1s 2ms/step - accuracy: 0.2333 - loss: 2.7619 - val_accuracy: 0.2780 - val_loss: 2.6720
Epoch 40/50
530/530 1s 3ms/step - accuracy: 0.2429 - loss: 2.7584 - val_accuracy: 0.2650 - val_loss: 2.4843
Epoch 41/50
530/530 1s 3ms/step - accuracy: 0.2329 - loss: 2.7799 - val_accuracy: 0.3230 - val_loss: 2.5149
Epoch 42/50
530/530 3s 4ms/step - accuracy: 0.2435 - loss: 2.7581 - val_accuracy: 0.2730 - val_loss: 2.4996
Epoch 43/50
530/530 2s 3ms/step - accuracy: 0.2352 - loss: 2.7745 - val_accuracy: 0.2220 - val_loss: 2.6920
Epoch 44/50
530/530 3s 3ms/step - accuracy: 0.2404 - loss: 2.7603 - val_accuracy: 0.2830 - val_loss: 2.5264
Epoch 45/50
530/530 1s 3ms/step - accuracy: 0.2398 - loss: 2.7412 - val_accuracy: 0.3040 - val_loss: 2.5909
Epoch 46/50
530/530 2s 3ms/step - accuracy: 0.2428 - loss: 2.7566 - val_accuracy: 0.2510 - val_loss: 2.6826
Epoch 47/50
530/530 3s 3ms/step - accuracy: 0.2343 - loss: 2.7553 - val_accuracy: 0.3430 - val_loss: 2.4751
Epoch 48/50
530/530 2s 4ms/step - accuracy: 0.2305 - loss: 2.7818 - val_accuracy: 0.2700 - val_loss: 2.6099
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.2439 - loss: 2.7522 - val_accuracy: 0.2780 - val_loss: 2.5800
Epoch 50/50
530/530 1s 3ms/step - accuracy: 0.2436 - loss: 2.7613 - val_accuracy: 0.2710 - val_loss: 2.5340
Accuracy: 0.2660
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_10"

Layer (type)	Output Shape	Param #
dense_40 (Dense)	(None, 64)	704
batch_normalization_30 (BatchNormalization)	(None, 64)	256
dropout_30 (Dropout)	(None, 64)	0
dense_41 (Dense)	(None, 32)	2,080
batch_normalization_31 (BatchNormalization)	(None, 32)	128
dropout_31 (Dropout)	(None, 32)	0
dense_42 (Dense)	(None, 16)	528
batch_normalization_32 (BatchNormalization)	(None, 16)	64
dropout_32 (Dropout)	(None, 16)	0
dense_43 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
265/265 4s 7ms/step - accuracy: 0.2477 - loss: 2.7351 - val_accuracy: 0.2500 - val_loss: 2.5362
Epoch 2/50
265/265 1s 3ms/step - accuracy: 0.2845 - loss: 2.5206 - val_accuracy: 0.3480 - val_loss: 2.3775
Epoch 3/50
265/265 1s 3ms/step - accuracy: 0.3032 - loss: 2.4626 - val_accuracy: 0.3440 - val_loss: 2.3317
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.3102 - loss: 2.4479 - val_accuracy: 0.3090 - val_loss: 2.3887
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.3001 - loss: 2.4552 - val_accuracy: 0.3870 - val_loss: 2.1987
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.3006 - loss: 2.4749 - val_accuracy: 0.3000 - val_loss: 2.4069
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.3119 - loss: 2.4373 - val_accuracy: 0.3280 - val_loss: 2.3295
Epoch 8/50
265/265 1s 3ms/step - accuracy: 0.3180 - loss: 2.4270 - val_accuracy: 0.3590 - val_loss: 2.2177
Epoch 9/50
265/265 1s 3ms/step - accuracy: 0.3157 - loss: 2.4290 - val_accuracy: 0.3440 - val_loss: 2.4158
Epoch 10/50
265/265 1s 3ms/step - accuracy: 0.3157 - loss: 2.4187 - val_accuracy: 0.2960 - val_loss: 2.4045
Epoch 11/50
265/265 1s 3ms/step - accuracy: 0.3179 - loss: 2.4183 - val_accuracy: 0.3330 - val_loss: 2.4213
Epoch 12/50
265/265 1s 3ms/step - accuracy: 0.3116 - loss: 2.4493 - val_accuracy: 0.3810 - val_loss: 2.2185
Epoch 13/50
265/265 1s 3ms/step - accuracy: 0.3199 - loss: 2.4085 - val_accuracy: 0.3720 - val_loss: 2.2758
Epoch 14/50
265/265 1s 3ms/step - accuracy: 0.3292 - loss: 2.4165 - val_accuracy: 0.3410 - val_loss: 2.2242
Epoch 15/50
265/265 1s 3ms/step - accuracy: 0.3180 - loss: 2.4345 - val_accuracy: 0.3670 - val_loss: 2.3247
Epoch 16/50
265/265 1s 3ms/step - accuracy: 0.3262 - loss: 2.4317 - val_accuracy: 0.3730 - val_loss: 2.2035
Epoch 17/50
265/265 1s 3ms/step - accuracy: 0.3258 - loss: 2.3953 - val_accuracy: 0.3650 - val_loss: 2.2873
Epoch 18/50
265/265 2s 4ms/step - accuracy: 0.3344 - loss: 2.3816 - val_accuracy: 0.3880 - val_loss: 2.2130
Epoch 19/50
265/265 1s 4ms/step - accuracy: 0.3264 - loss: 2.3819 - val_accuracy: 0.3770 - val_loss: 2.3236
Epoch 20/50
265/265 1s 3ms/step - accuracy: 0.3239 - loss: 2.4261 - val_accuracy: 0.3300 - val_loss: 2.4563
Epoch 21/50
265/265 1s 3ms/step - accuracy: 0.3181 - loss: 2.4217 - val_accuracy: 0.3460 - val_loss: 2.3602
Epoch 22/50
265/265 1s 3ms/step - accuracy: 0.3263 - loss: 2.4198 - val_accuracy: 0.3380 - val_loss: 2.3225
Epoch 23/50
265/265 1s 3ms/step - accuracy: 0.3306 - loss: 2.4035 - val_accuracy: 0.3500 - val_loss: 2.2391
Epoch 24/50
265/265 1s 3ms/step - accuracy: 0.3297 - loss: 2.3916 - val_accuracy: 0.3460 - val_loss: 2.2275
Epoch 25/50
265/265 1s 3ms/step - accuracy: 0.3264 - loss: 2.3736 - val_accuracy: 0.2880 - val_loss: 2.5266
Epoch 26/50
265/265 1s 3ms/step - accuracy: 0.3248 - loss: 2.4328 - val_accuracy: 0.3620 - val_loss: 2.3643
Epoch 27/50
265/265 1s 3ms/step - accuracy: 0.3267 - loss: 2.3957 - val_accuracy: 0.3610 - val_loss: 2.3261

```
Epoch 28/50
265/265 1s 3ms/step - accuracy: 0.3303 - loss: 2.3796 - val_accuracy: 0.4240 - val_loss: 2.2016
Epoch 29/50
265/265 1s 3ms/step - accuracy: 0.3295 - loss: 2.4039 - val_accuracy: 0.3400 - val_loss: 2.3241
Epoch 30/50
265/265 1s 3ms/step - accuracy: 0.3310 - loss: 2.3879 - val_accuracy: 0.4150 - val_loss: 2.1654
Epoch 31/50
265/265 1s 3ms/step - accuracy: 0.3378 - loss: 2.3685 - val_accuracy: 0.3960 - val_loss: 2.2619
Epoch 32/50
265/265 2s 4ms/step - accuracy: 0.3311 - loss: 2.4027 - val_accuracy: 0.3630 - val_loss: 2.2037
Epoch 33/50
265/265 1s 5ms/step - accuracy: 0.3195 - loss: 2.4160 - val_accuracy: 0.3420 - val_loss: 2.2759
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.3341 - loss: 2.3804 - val_accuracy: 0.4200 - val_loss: 2.1623
Epoch 35/50
265/265 1s 3ms/step - accuracy: 0.3407 - loss: 2.3877 - val_accuracy: 0.3580 - val_loss: 2.3530
Epoch 36/50
265/265 1s 3ms/step - accuracy: 0.3391 - loss: 2.3772 - val_accuracy: 0.3890 - val_loss: 2.2293
Epoch 37/50
265/265 1s 3ms/step - accuracy: 0.3352 - loss: 2.3950 - val_accuracy: 0.3960 - val_loss: 2.2445
Epoch 38/50
265/265 1s 3ms/step - accuracy: 0.3297 - loss: 2.3993 - val_accuracy: 0.3990 - val_loss: 2.2017
Epoch 39/50
265/265 1s 3ms/step - accuracy: 0.3407 - loss: 2.4008 - val_accuracy: 0.3870 - val_loss: 2.2296
Epoch 40/50
265/265 1s 3ms/step - accuracy: 0.3426 - loss: 2.3815 - val_accuracy: 0.4180 - val_loss: 2.2214
Epoch 41/50
265/265 1s 3ms/step - accuracy: 0.3449 - loss: 2.3565 - val_accuracy: 0.3190 - val_loss: 2.4161
Epoch 42/50
265/265 1s 3ms/step - accuracy: 0.3348 - loss: 2.3977 - val_accuracy: 0.3090 - val_loss: 2.4745
Epoch 43/50
265/265 1s 3ms/step - accuracy: 0.3377 - loss: 2.3998 - val_accuracy: 0.3960 - val_loss: 2.2321
Epoch 44/50
265/265 1s 3ms/step - accuracy: 0.3289 - loss: 2.4219 - val_accuracy: 0.3310 - val_loss: 2.4435
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.3416 - loss: 2.3995 - val_accuracy: 0.4230 - val_loss: 2.1697
Epoch 46/50
265/265 1s 4ms/step - accuracy: 0.3466 - loss: 2.3745 - val_accuracy: 0.3400 - val_loss: 2.4382
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.3359 - loss: 2.4237 - val_accuracy: 0.4010 - val_loss: 2.1884
Epoch 48/50
265/265 1s 3ms/step - accuracy: 0.3368 - loss: 2.3951 - val_accuracy: 0.3470 - val_loss: 2.3362
Epoch 49/50
265/265 1s 3ms/step - accuracy: 0.3348 - loss: 2.3752 - val_accuracy: 0.3730 - val_loss: 2.2790
Epoch 50/50
265/265 1s 3ms/step - accuracy: 0.3286 - loss: 2.4287 - val_accuracy: 0.3100 - val_loss: 2.4017
Accuracy: 0.3025
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_11"

Layer (type)	Output Shape	Param #
dense_44 (Dense)	(None, 64)	704
batch_normalization_33 (BatchNormalization)	(None, 64)	256
dropout_33 (Dropout)	(None, 64)	0
dense_45 (Dense)	(None, 32)	2,080
batch_normalization_34 (BatchNormalization)	(None, 32)	128
dropout_34 (Dropout)	(None, 32)	0
dense_46 (Dense)	(None, 16)	528
batch_normalization_35 (BatchNormalization)	(None, 16)	64
dropout_35 (Dropout)	(None, 16)	0
dense_47 (Dense)	(None, 20)	340

Total params: 4,100 (16.02 KB)

Trainable params: 3,876 (15.14 KB)

Non-trainable params: 224 (896.00 B)

None
Model compiled.
Epoch 1/50
265/265 4s 4ms/step - accuracy: 0.1866 - loss: 2.8724 - val_accuracy: 0.2990 - val_loss: 2.5401
Epoch 2/50
265/265 1s 3ms/step - accuracy: 0.2392 - loss: 2.6440 - val_accuracy: 0.3100 - val_loss: 2.4303
Epoch 3/50
265/265 1s 3ms/step - accuracy: 0.2460 - loss: 2.6078 - val_accuracy: 0.2320 - val_loss: 2.5482
Epoch 4/50
265/265 2s 4ms/step - accuracy: 0.2545 - loss: 2.5872 - val_accuracy: 0.2650 - val_loss: 2.6068
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.2586 - loss: 2.5874 - val_accuracy: 0.2080 - val_loss: 2.4833
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.2652 - loss: 2.5872 - val_accuracy: 0.2580 - val_loss: 2.5956
Epoch 7/50
265/265 1s 3ms/step - accuracy: 0.2650 - loss: 2.5930 - val_accuracy: 0.2600 - val_loss: 2.6549
Epoch 8/50
265/265 1s 3ms/step - accuracy: 0.2677 - loss: 2.5942 - val_accuracy: 0.2740 - val_loss: 2.4427
Epoch 9/50
265/265 1s 3ms/step - accuracy: 0.2769 - loss: 2.5704 - val_accuracy: 0.2940 - val_loss: 2.5535
Epoch 10/50
265/265 1s 3ms/step - accuracy: 0.2732 - loss: 2.5621 - val_accuracy: 0.3170 - val_loss: 2.3514
Epoch 11/50
265/265 1s 3ms/step - accuracy: 0.2699 - loss: 2.5715 - val_accuracy: 0.3440 - val_loss: 2.3544
Epoch 12/50
265/265 1s 3ms/step - accuracy: 0.2794 - loss: 2.5654 - val_accuracy: 0.3220 - val_loss: 2.3402
Epoch 13/50
265/265 1s 3ms/step - accuracy: 0.2719 - loss: 2.5497 - val_accuracy: 0.3310 - val_loss: 2.4776
Epoch 14/50
265/265 1s 3ms/step - accuracy: 0.2755 - loss: 2.5574 - val_accuracy: 0.2590 - val_loss: 2.5057
Epoch 15/50
265/265 1s 3ms/step - accuracy: 0.2610 - loss: 2.6072 - val_accuracy: 0.3230 - val_loss: 2.3982
Epoch 16/50
265/265 1s 3ms/step - accuracy: 0.2625 - loss: 2.5887 - val_accuracy: 0.3410 - val_loss: 2.2929
Epoch 17/50
265/265 2s 4ms/step - accuracy: 0.2871 - loss: 2.5459 - val_accuracy: 0.2860 - val_loss: 2.4631
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.2752 - loss: 2.5684 - val_accuracy: 0.3430 - val_loss: 2.2433
Epoch 19/50
265/265 1s 5ms/step - accuracy: 0.2765 - loss: 2.5703 - val_accuracy: 0.3570 - val_loss: 2.3063
Epoch 20/50
265/265 1s 3ms/step - accuracy: 0.2817 - loss: 2.5696 - val_accuracy: 0.3180 - val_loss: 2.3903
Epoch 21/50
265/265 1s 3ms/step - accuracy: 0.2767 - loss: 2.5507 - val_accuracy: 0.3150 - val_loss: 2.3505
Epoch 22/50
265/265 1s 3ms/step - accuracy: 0.2724 - loss: 2.5632 - val_accuracy: 0.3320 - val_loss: 2.3225
Epoch 23/50
265/265 1s 3ms/step - accuracy: 0.2695 - loss: 2.5842 - val_accuracy: 0.3320 - val_loss: 2.3743
Epoch 24/50
265/265 1s 3ms/step - accuracy: 0.2835 - loss: 2.5197 - val_accuracy: 0.3370 - val_loss: 2.2883
Epoch 25/50
265/265 1s 3ms/step - accuracy: 0.2786 - loss: 2.5605 - val_accuracy: 0.2760 - val_loss: 2.4381
Epoch 26/50
265/265 1s 3ms/step - accuracy: 0.2793 - loss: 2.5651 - val_accuracy: 0.3420 - val_loss: 2.3890
Epoch 27/50
265/265 1s 3ms/step - accuracy: 0.2853 - loss: 2.5640 - val_accuracy: 0.3030 - val_loss: 2.4058

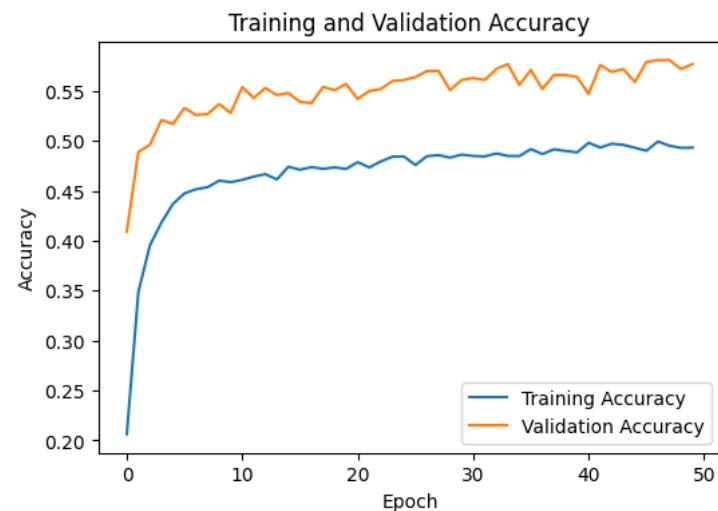
```
Epoch 28/50
265/265 1s 3ms/step - accuracy: 0.2691 - loss: 2.5670 - val_accuracy: 0.3010 - val_loss: 2.4319
Epoch 29/50
265/265 1s 3ms/step - accuracy: 0.2775 - loss: 2.5666 - val_accuracy: 0.3330 - val_loss: 2.4557
Epoch 30/50
265/265 1s 3ms/step - accuracy: 0.2805 - loss: 2.5709 - val_accuracy: 0.2940 - val_loss: 2.3877
Epoch 31/50
265/265 1s 4ms/step - accuracy: 0.2807 - loss: 2.5284 - val_accuracy: 0.2770 - val_loss: 2.3529
Epoch 32/50
265/265 1s 4ms/step - accuracy: 0.2777 - loss: 2.5445 - val_accuracy: 0.3180 - val_loss: 2.3842
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.2906 - loss: 2.5347 - val_accuracy: 0.3350 - val_loss: 2.3148
Epoch 34/50
265/265 1s 3ms/step - accuracy: 0.2879 - loss: 2.5244 - val_accuracy: 0.2550 - val_loss: 2.6949
Epoch 35/50
265/265 1s 3ms/step - accuracy: 0.2837 - loss: 2.5546 - val_accuracy: 0.3540 - val_loss: 2.4304
Epoch 36/50
265/265 1s 3ms/step - accuracy: 0.2834 - loss: 2.5671 - val_accuracy: 0.3370 - val_loss: 2.4305
Epoch 37/50
265/265 1s 3ms/step - accuracy: 0.2905 - loss: 2.5689 - val_accuracy: 0.3120 - val_loss: 2.5242
Epoch 38/50
265/265 1s 3ms/step - accuracy: 0.2886 - loss: 2.5472 - val_accuracy: 0.3490 - val_loss: 2.3298
Epoch 39/50
265/265 1s 3ms/step - accuracy: 0.2822 - loss: 2.5686 - val_accuracy: 0.2790 - val_loss: 2.4505
Epoch 40/50
265/265 1s 3ms/step - accuracy: 0.2772 - loss: 2.5633 - val_accuracy: 0.3100 - val_loss: 2.3917
Epoch 41/50
265/265 1s 3ms/step - accuracy: 0.2794 - loss: 2.5334 - val_accuracy: 0.3240 - val_loss: 2.3657
Epoch 42/50
265/265 1s 3ms/step - accuracy: 0.2792 - loss: 2.5624 - val_accuracy: 0.3370 - val_loss: 2.4021
Epoch 43/50
265/265 2s 4ms/step - accuracy: 0.3015 - loss: 2.5305 - val_accuracy: 0.3020 - val_loss: 2.4348
Epoch 44/50
265/265 1s 4ms/step - accuracy: 0.2878 - loss: 2.5435 - val_accuracy: 0.3590 - val_loss: 2.3192
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.2821 - loss: 2.5647 - val_accuracy: 0.3530 - val_loss: 2.3327
Epoch 46/50
265/265 1s 3ms/step - accuracy: 0.2729 - loss: 2.5642 - val_accuracy: 0.3520 - val_loss: 2.3220
Epoch 47/50
265/265 1s 3ms/step - accuracy: 0.2757 - loss: 2.5678 - val_accuracy: 0.3530 - val_loss: 2.4151
Epoch 48/50
265/265 1s 3ms/step - accuracy: 0.2869 - loss: 2.5667 - val_accuracy: 0.2960 - val_loss: 2.4436
Epoch 49/50
265/265 1s 3ms/step - accuracy: 0.2911 - loss: 2.5429 - val_accuracy: 0.3500 - val_loss: 2.3190
Epoch 50/50
265/265 1s 3ms/step - accuracy: 0.2889 - loss: 2.5373 - val_accuracy: 0.3230 - val_loss: 2.3578
Accuracy: 0.3170
```

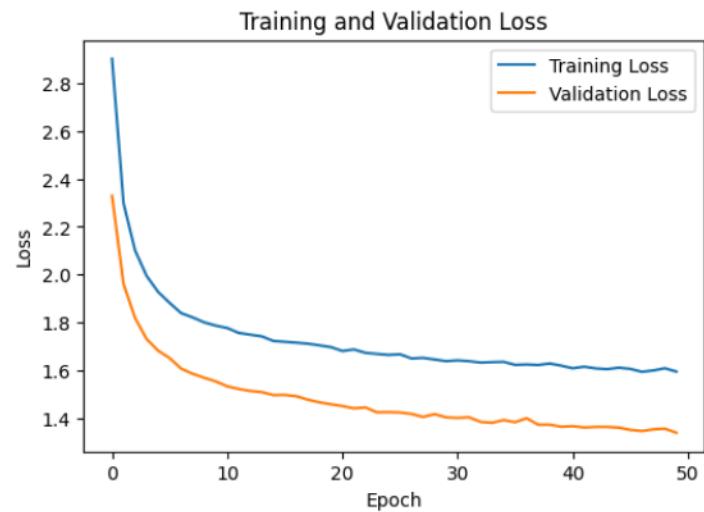
```
Best Hyperparameters:
{'learning_rate': 0.001, 'batch_size': 64, 'dropout': 0.2}
Best Accuracy: 0.5740
```

```
In [ ]: plt.figure(figsize=(6, 4))
plt.plot(best_history.history['accuracy'], label='Training Accuracy')
plt.plot(best_history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Training and Validation Accuracy')
```

```
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

plt.figure(figsize=(6, 4))
plt.plot(best_history.history['loss'], label='Training Loss')
plt.plot(best_history.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```





```
In [ ]: best_model.evaluate(X_test, y_test)
63/63 0s 1ms/step - accuracy: 0.5773 - loss: 1.3965
[1.3894131183624268, 0.574000009536743]
Out[ ]:
```

6 Layer Neural Network

```
In [ ]: learning_rates = [0.001, 0.01, 0.1]
batch_sizes = [32, 64]
dropout = [0.1, 0.2, 0.3]
best_accuracy = 0
input_shape = X_train.shape[1:]
best_history = None
best_model = None

for lr in learning_rates:
    for batch in batch_sizes:
        for d in dropout:
            model = Six_Layer_NN()
            config = {
                'input_shape': input_shape,
                'epochs': 50,
                'dropout': d,
                'batch_size': batch,
                'lr': lr
            }
            model.build_model(config)
            history = model.train(X_train, y_train, X_valid, y_valid, config)
            loss, accuracy = model.evaluate(X_test, y_test, verbose=0)
```

```
print(f"Accuracy: {accuracy:.4f}")

if accuracy > best_accuracy:
    best_model = model
    best_accuracy = accuracy
    best_params = {'learning_rate': lr, 'batch_size': batch, 'dropout': d}
    best_history = history

print("\nBest Hyperparameters:")
print(best_params)
print(f"Best Accuracy: {best_accuracy:.4f}")

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.

/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
Argument `decay` is no longer supported and will be ignored.

Model: "sequential_12"
```

Layer (type)	Output Shape	Param #
dense_48 (Dense)	(None, 32)	352
batch_normalization_36 (BatchNormalization)	(None, 32)	128
dropout_36 (Dropout)	(None, 32)	0
dense_49 (Dense)	(None, 64)	2,112
batch_normalization_37 (BatchNormalization)	(None, 64)	256
dropout_37 (Dropout)	(None, 64)	0
dense_50 (Dense)	(None, 32)	2,080
batch_normalization_38 (BatchNormalization)	(None, 32)	128
dropout_38 (Dropout)	(None, 32)	0
dense_51 (Dense)	(None, 16)	528
batch_normalization_39 (BatchNormalization)	(None, 16)	64
dropout_39 (Dropout)	(None, 16)	0
dense_52 (Dense)	(None, 32)	544
batch_normalization_40 (BatchNormalization)	(None, 32)	128
dropout_40 (Dropout)	(None, 32)	0
dense_53 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 7s 6ms/step - accuracy: 0.1728 - loss: 3.1767 - val_accuracy: 0.4760 - val_loss: 1.9919
Epoch 2/50
530/530 4s 3ms/step - accuracy: 0.3832 - loss: 2.2027 - val_accuracy: 0.5140 - val_loss: 1.7549
Epoch 3/50
530/530 3s 3ms/step - accuracy: 0.4171 - loss: 2.0012 - val_accuracy: 0.5250 - val_loss: 1.6284
Epoch 4/50
530/530 2s 3ms/step - accuracy: 0.4518 - loss: 1.8686 - val_accuracy: 0.5540 - val_loss: 1.5688
Epoch 5/50
530/530 3s 3ms/step - accuracy: 0.4622 - loss: 1.8054 - val_accuracy: 0.5430 - val_loss: 1.5236
Epoch 6/50
530/530 3s 5ms/step - accuracy: 0.4661 - loss: 1.7732 - val_accuracy: 0.5600 - val_loss: 1.4839
Epoch 7/50
530/530 4s 3ms/step - accuracy: 0.4709 - loss: 1.7483 - val_accuracy: 0.5610 - val_loss: 1.4734
Epoch 8/50
530/530 3s 3ms/step - accuracy: 0.4726 - loss: 1.7248 - val_accuracy: 0.5560 - val_loss: 1.4500
Epoch 9/50
530/530 2s 3ms/step - accuracy: 0.4798 - loss: 1.6951 - val_accuracy: 0.5630 - val_loss: 1.4161
Epoch 10/50
530/530 2s 3ms/step - accuracy: 0.4798 - loss: 1.6841 - val_accuracy: 0.5730 - val_loss: 1.4094
Epoch 11/50
530/530 2s 4ms/step - accuracy: 0.4921 - loss: 1.6530 - val_accuracy: 0.5690 - val_loss: 1.3993
Epoch 12/50
530/530 3s 5ms/step - accuracy: 0.4978 - loss: 1.6210 - val_accuracy: 0.5830 - val_loss: 1.3720
Epoch 13/50
530/530 4s 3ms/step - accuracy: 0.4928 - loss: 1.6468 - val_accuracy: 0.5700 - val_loss: 1.3972
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.4983 - loss: 1.6153 - val_accuracy: 0.5720 - val_loss: 1.3650
Epoch 15/50
530/530 2s 3ms/step - accuracy: 0.4948 - loss: 1.6286 - val_accuracy: 0.5790 - val_loss: 1.3359
Epoch 16/50
530/530 2s 3ms/step - accuracy: 0.5001 - loss: 1.6063 - val_accuracy: 0.5820 - val_loss: 1.3365
Epoch 17/50
530/530 2s 4ms/step - accuracy: 0.4939 - loss: 1.6107 - val_accuracy: 0.5830 - val_loss: 1.3488
Epoch 18/50
530/530 3s 5ms/step - accuracy: 0.5067 - loss: 1.5957 - val_accuracy: 0.5880 - val_loss: 1.3131
Epoch 19/50
530/530 2s 3ms/step - accuracy: 0.5017 - loss: 1.5910 - val_accuracy: 0.5880 - val_loss: 1.3158
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.5040 - loss: 1.5936 - val_accuracy: 0.5990 - val_loss: 1.2954
Epoch 21/50
530/530 2s 3ms/step - accuracy: 0.5157 - loss: 1.5720 - val_accuracy: 0.5940 - val_loss: 1.3014
Epoch 22/50
530/530 3s 3ms/step - accuracy: 0.5115 - loss: 1.5623 - val_accuracy: 0.5840 - val_loss: 1.3052
Epoch 23/50
530/530 2s 3ms/step - accuracy: 0.5082 - loss: 1.5662 - val_accuracy: 0.5900 - val_loss: 1.3023
Epoch 24/50
530/530 2s 4ms/step - accuracy: 0.5102 - loss: 1.5562 - val_accuracy: 0.5900 - val_loss: 1.2866
Epoch 25/50
530/530 2s 5ms/step - accuracy: 0.5096 - loss: 1.5678 - val_accuracy: 0.5980 - val_loss: 1.2887
Epoch 26/50
530/530 2s 3ms/step - accuracy: 0.5123 - loss: 1.5561 - val_accuracy: 0.5980 - val_loss: 1.2792
Epoch 27/50
530/530 2s 3ms/step - accuracy: 0.5064 - loss: 1.5560 - val_accuracy: 0.6000 - val_loss: 1.2864

```
Epoch 28/50
530/530 2s 3ms/step - accuracy: 0.5073 - loss: 1.5624 - val_accuracy: 0.5910 - val_loss: 1.3030
Epoch 29/50
530/530 2s 3ms/step - accuracy: 0.5069 - loss: 1.5643 - val_accuracy: 0.5990 - val_loss: 1.2670
Epoch 30/50
530/530 3s 3ms/step - accuracy: 0.5134 - loss: 1.5611 - val_accuracy: 0.5990 - val_loss: 1.2743
Epoch 31/50
530/530 2s 4ms/step - accuracy: 0.5150 - loss: 1.5526 - val_accuracy: 0.6020 - val_loss: 1.2816
Epoch 32/50
530/530 3s 5ms/step - accuracy: 0.5154 - loss: 1.5503 - val_accuracy: 0.5860 - val_loss: 1.2906
Epoch 33/50
530/530 2s 3ms/step - accuracy: 0.5085 - loss: 1.5455 - val_accuracy: 0.6090 - val_loss: 1.2615
Epoch 34/50
530/530 2s 3ms/step - accuracy: 0.5155 - loss: 1.5419 - val_accuracy: 0.5910 - val_loss: 1.2904
Epoch 35/50
530/530 3s 3ms/step - accuracy: 0.5167 - loss: 1.5485 - val_accuracy: 0.6040 - val_loss: 1.2680
Epoch 36/50
530/530 3s 3ms/step - accuracy: 0.5216 - loss: 1.5250 - val_accuracy: 0.6020 - val_loss: 1.2783
Epoch 37/50
530/530 2s 4ms/step - accuracy: 0.5180 - loss: 1.5207 - val_accuracy: 0.5940 - val_loss: 1.2515
Epoch 38/50
530/530 3s 5ms/step - accuracy: 0.5201 - loss: 1.5235 - val_accuracy: 0.5960 - val_loss: 1.2687
Epoch 39/50
530/530 2s 3ms/step - accuracy: 0.5249 - loss: 1.5069 - val_accuracy: 0.6110 - val_loss: 1.2476
Epoch 40/50
530/530 2s 3ms/step - accuracy: 0.5253 - loss: 1.5244 - val_accuracy: 0.5900 - val_loss: 1.2621
Epoch 41/50
530/530 2s 3ms/step - accuracy: 0.5087 - loss: 1.5458 - val_accuracy: 0.6100 - val_loss: 1.2608
Epoch 42/50
530/530 3s 3ms/step - accuracy: 0.5233 - loss: 1.5273 - val_accuracy: 0.5990 - val_loss: 1.2457
Epoch 43/50
530/530 3s 3ms/step - accuracy: 0.5286 - loss: 1.5287 - val_accuracy: 0.5960 - val_loss: 1.2589
Epoch 44/50
530/530 3s 5ms/step - accuracy: 0.5107 - loss: 1.5364 - val_accuracy: 0.5980 - val_loss: 1.2446
Epoch 45/50
530/530 2s 3ms/step - accuracy: 0.5183 - loss: 1.5199 - val_accuracy: 0.6080 - val_loss: 1.2530
Epoch 46/50
530/530 2s 3ms/step - accuracy: 0.5261 - loss: 1.5084 - val_accuracy: 0.6100 - val_loss: 1.2457
Epoch 47/50
530/530 2s 3ms/step - accuracy: 0.5267 - loss: 1.5024 - val_accuracy: 0.6190 - val_loss: 1.2321
Epoch 48/50
530/530 2s 3ms/step - accuracy: 0.5219 - loss: 1.5141 - val_accuracy: 0.6090 - val_loss: 1.2561
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.5305 - loss: 1.4878 - val_accuracy: 0.6110 - val_loss: 1.2461
Epoch 50/50
530/530 2s 4ms/step - accuracy: 0.5190 - loss: 1.5207 - val_accuracy: 0.6170 - val_loss: 1.2292
Accuracy: 0.5920
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_13"

Layer (type)	Output Shape	Param #
dense_54 (Dense)	(None, 32)	352
batch_normalization_41 (BatchNormalization)	(None, 32)	128
dropout_41 (Dropout)	(None, 32)	0
dense_55 (Dense)	(None, 64)	2,112
batch_normalization_42 (BatchNormalization)	(None, 64)	256
dropout_42 (Dropout)	(None, 64)	0
dense_56 (Dense)	(None, 32)	2,080
batch_normalization_43 (BatchNormalization)	(None, 32)	128
dropout_43 (Dropout)	(None, 32)	0
dense_57 (Dense)	(None, 16)	528
batch_normalization_44 (BatchNormalization)	(None, 16)	64
dropout_44 (Dropout)	(None, 16)	0
dense_58 (Dense)	(None, 32)	544
batch_normalization_45 (BatchNormalization)	(None, 32)	128
dropout_45 (Dropout)	(None, 32)	0
dense_59 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 7s 4ms/step - accuracy: 0.1133 - loss: 3.3656 - val_accuracy: 0.4180 - val_loss: 2.2183
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.2737 - loss: 2.4675 - val_accuracy: 0.4400 - val_loss: 1.9275
Epoch 3/50
530/530 2s 3ms/step - accuracy: 0.3263 - loss: 2.2238 - val_accuracy: 0.4820 - val_loss: 1.7790
Epoch 4/50
530/530 2s 3ms/step - accuracy: 0.3628 - loss: 2.0941 - val_accuracy: 0.4840 - val_loss: 1.7022
Epoch 5/50
530/530 2s 4ms/step - accuracy: 0.3866 - loss: 2.0151 - val_accuracy: 0.4990 - val_loss: 1.6378
Epoch 6/50
530/530 3s 5ms/step - accuracy: 0.3972 - loss: 1.9724 - val_accuracy: 0.5090 - val_loss: 1.6038
Epoch 7/50
530/530 4s 3ms/step - accuracy: 0.4001 - loss: 1.9422 - val_accuracy: 0.4950 - val_loss: 1.5861
Epoch 8/50
530/530 2s 3ms/step - accuracy: 0.4004 - loss: 1.9239 - val_accuracy: 0.5060 - val_loss: 1.5472
Epoch 9/50
530/530 3s 3ms/step - accuracy: 0.4082 - loss: 1.8993 - val_accuracy: 0.5320 - val_loss: 1.5423
Epoch 10/50
530/530 2s 3ms/step - accuracy: 0.4230 - loss: 1.8779 - val_accuracy: 0.5240 - val_loss: 1.5125
Epoch 11/50
530/530 3s 5ms/step - accuracy: 0.4263 - loss: 1.8508 - val_accuracy: 0.5130 - val_loss: 1.5297
Epoch 12/50
530/530 2s 3ms/step - accuracy: 0.4290 - loss: 1.8428 - val_accuracy: 0.5400 - val_loss: 1.4900
Epoch 13/50
530/530 3s 3ms/step - accuracy: 0.4386 - loss: 1.8261 - val_accuracy: 0.5270 - val_loss: 1.4934
Epoch 14/50
530/530 3s 3ms/step - accuracy: 0.4252 - loss: 1.8415 - val_accuracy: 0.5340 - val_loss: 1.4796
Epoch 15/50
530/530 2s 3ms/step - accuracy: 0.4378 - loss: 1.8085 - val_accuracy: 0.5430 - val_loss: 1.4599
Epoch 16/50
530/530 2s 3ms/step - accuracy: 0.4469 - loss: 1.7906 - val_accuracy: 0.5370 - val_loss: 1.4661
Epoch 17/50
530/530 2s 5ms/step - accuracy: 0.4480 - loss: 1.7877 - val_accuracy: 0.5410 - val_loss: 1.4600
Epoch 18/50
530/530 2s 4ms/step - accuracy: 0.4531 - loss: 1.7842 - val_accuracy: 0.5290 - val_loss: 1.4540
Epoch 19/50
530/530 2s 3ms/step - accuracy: 0.4514 - loss: 1.7643 - val_accuracy: 0.5320 - val_loss: 1.4511
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.4520 - loss: 1.7546 - val_accuracy: 0.5510 - val_loss: 1.4347
Epoch 21/50
530/530 3s 3ms/step - accuracy: 0.4548 - loss: 1.7522 - val_accuracy: 0.5460 - val_loss: 1.4288
Epoch 22/50
530/530 3s 3ms/step - accuracy: 0.4542 - loss: 1.7804 - val_accuracy: 0.5460 - val_loss: 1.4239
Epoch 23/50
530/530 3s 5ms/step - accuracy: 0.4480 - loss: 1.7783 - val_accuracy: 0.5490 - val_loss: 1.4285
Epoch 24/50
530/530 2s 3ms/step - accuracy: 0.4571 - loss: 1.7594 - val_accuracy: 0.5550 - val_loss: 1.4273
Epoch 25/50
530/530 2s 3ms/step - accuracy: 0.4603 - loss: 1.7458 - val_accuracy: 0.5490 - val_loss: 1.4228
Epoch 26/50
530/530 3s 3ms/step - accuracy: 0.4568 - loss: 1.7480 - val_accuracy: 0.5330 - val_loss: 1.4128
Epoch 27/50
530/530 2s 3ms/step - accuracy: 0.4577 - loss: 1.7219 - val_accuracy: 0.5530 - val_loss: 1.4118

```
Epoch 28/50
530/530 2s 3ms/step - accuracy: 0.4533 - loss: 1.7572 - val_accuracy: 0.5580 - val_loss: 1.4034
Epoch 29/50
530/530 2s 4ms/step - accuracy: 0.4591 - loss: 1.7421 - val_accuracy: 0.5670 - val_loss: 1.3910
Epoch 30/50
530/530 2s 4ms/step - accuracy: 0.4574 - loss: 1.7404 - val_accuracy: 0.5710 - val_loss: 1.3875
Epoch 31/50
530/530 2s 3ms/step - accuracy: 0.4620 - loss: 1.7287 - val_accuracy: 0.5570 - val_loss: 1.3924
Epoch 32/50
530/530 2s 3ms/step - accuracy: 0.4550 - loss: 1.7481 - val_accuracy: 0.5600 - val_loss: 1.3844
Epoch 33/50
530/530 3s 3ms/step - accuracy: 0.4598 - loss: 1.7244 - val_accuracy: 0.5560 - val_loss: 1.3756
Epoch 34/50
530/530 3s 3ms/step - accuracy: 0.4650 - loss: 1.7214 - val_accuracy: 0.5720 - val_loss: 1.3900
Epoch 35/50
530/530 2s 5ms/step - accuracy: 0.4619 - loss: 1.7336 - val_accuracy: 0.5590 - val_loss: 1.3828
Epoch 36/50
530/530 2s 4ms/step - accuracy: 0.4635 - loss: 1.7127 - val_accuracy: 0.5660 - val_loss: 1.3736
Epoch 37/50
530/530 2s 3ms/step - accuracy: 0.4672 - loss: 1.7201 - val_accuracy: 0.5620 - val_loss: 1.3778
Epoch 38/50
530/530 2s 3ms/step - accuracy: 0.4703 - loss: 1.6934 - val_accuracy: 0.5680 - val_loss: 1.3694
Epoch 39/50
530/530 2s 3ms/step - accuracy: 0.4574 - loss: 1.7265 - val_accuracy: 0.5680 - val_loss: 1.3633
Epoch 40/50
530/530 2s 3ms/step - accuracy: 0.4692 - loss: 1.6910 - val_accuracy: 0.5710 - val_loss: 1.3610
Epoch 41/50
530/530 3s 3ms/step - accuracy: 0.4664 - loss: 1.7051 - val_accuracy: 0.5640 - val_loss: 1.3939
Epoch 42/50
530/530 3s 5ms/step - accuracy: 0.4712 - loss: 1.7118 - val_accuracy: 0.5650 - val_loss: 1.3553
Epoch 43/50
530/530 2s 4ms/step - accuracy: 0.4604 - loss: 1.7151 - val_accuracy: 0.5740 - val_loss: 1.3590
Epoch 44/50
530/530 2s 3ms/step - accuracy: 0.4668 - loss: 1.7068 - val_accuracy: 0.5760 - val_loss: 1.3554
Epoch 45/50
530/530 2s 3ms/step - accuracy: 0.4727 - loss: 1.6923 - val_accuracy: 0.5760 - val_loss: 1.3612
Epoch 46/50
530/530 3s 3ms/step - accuracy: 0.4725 - loss: 1.6913 - val_accuracy: 0.5750 - val_loss: 1.3541
Epoch 47/50
530/530 2s 3ms/step - accuracy: 0.4610 - loss: 1.6965 - val_accuracy: 0.5790 - val_loss: 1.3370
Epoch 48/50
530/530 2s 3ms/step - accuracy: 0.4690 - loss: 1.6901 - val_accuracy: 0.5730 - val_loss: 1.3391
Epoch 49/50
530/530 3s 5ms/step - accuracy: 0.4649 - loss: 1.6992 - val_accuracy: 0.5620 - val_loss: 1.3614
Epoch 50/50
530/530 2s 4ms/step - accuracy: 0.4717 - loss: 1.6920 - val_accuracy: 0.5670 - val_loss: 1.3556
Accuracy: 0.5700
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_14"

Layer (type)	Output Shape	Param #
dense_60 (Dense)	(None, 32)	352
batch_normalization_46 (BatchNormalization)	(None, 32)	128
dropout_46 (Dropout)	(None, 32)	0
dense_61 (Dense)	(None, 64)	2,112
batch_normalization_47 (BatchNormalization)	(None, 64)	256
dropout_47 (Dropout)	(None, 64)	0
dense_62 (Dense)	(None, 32)	2,080
batch_normalization_48 (BatchNormalization)	(None, 32)	128
dropout_48 (Dropout)	(None, 32)	0
dense_63 (Dense)	(None, 16)	528
batch_normalization_49 (BatchNormalization)	(None, 16)	64
dropout_49 (Dropout)	(None, 16)	0
dense_64 (Dense)	(None, 32)	544
batch_normalization_50 (BatchNormalization)	(None, 32)	128
dropout_50 (Dropout)	(None, 32)	0
dense_65 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 6s 4ms/step - accuracy: 0.0905 - loss: 3.5267 - val_accuracy: 0.3750 - val_loss: 2.4199
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.2122 - loss: 2.6798 - val_accuracy: 0.4120 - val_loss: 2.1326
Epoch 3/50
530/530 3s 4ms/step - accuracy: 0.2660 - loss: 2.4104 - val_accuracy: 0.4310 - val_loss: 1.9700
Epoch 4/50
530/530 3s 5ms/step - accuracy: 0.3000 - loss: 2.2771 - val_accuracy: 0.4540 - val_loss: 1.8616
Epoch 5/50
530/530 2s 3ms/step - accuracy: 0.3130 - loss: 2.1935 - val_accuracy: 0.4720 - val_loss: 1.7844
Epoch 6/50
530/530 2s 3ms/step - accuracy: 0.3324 - loss: 2.1359 - val_accuracy: 0.4790 - val_loss: 1.7513
Epoch 7/50
530/530 2s 3ms/step - accuracy: 0.3362 - loss: 2.1085 - val_accuracy: 0.4830 - val_loss: 1.7175
Epoch 8/50
530/530 2s 3ms/step - accuracy: 0.3445 - loss: 2.0779 - val_accuracy: 0.4750 - val_loss: 1.6989
Epoch 9/50
530/530 2s 3ms/step - accuracy: 0.3535 - loss: 2.0606 - val_accuracy: 0.4690 - val_loss: 1.6808
Epoch 10/50
530/530 3s 5ms/step - accuracy: 0.3542 - loss: 2.0462 - val_accuracy: 0.4800 - val_loss: 1.6597
Epoch 11/50
530/530 2s 4ms/step - accuracy: 0.3572 - loss: 2.0280 - val_accuracy: 0.4890 - val_loss: 1.6267
Epoch 12/50
530/530 2s 3ms/step - accuracy: 0.3696 - loss: 2.0015 - val_accuracy: 0.4880 - val_loss: 1.6339
Epoch 13/50
530/530 2s 3ms/step - accuracy: 0.3720 - loss: 1.9900 - val_accuracy: 0.4840 - val_loss: 1.6205
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.3786 - loss: 1.9806 - val_accuracy: 0.4850 - val_loss: 1.6077
Epoch 15/50
530/530 3s 3ms/step - accuracy: 0.3724 - loss: 1.9797 - val_accuracy: 0.4800 - val_loss: 1.6123
Epoch 16/50
530/530 3s 5ms/step - accuracy: 0.3762 - loss: 1.9869 - val_accuracy: 0.4830 - val_loss: 1.5905
Epoch 17/50
530/530 2s 4ms/step - accuracy: 0.3822 - loss: 1.9642 - val_accuracy: 0.4970 - val_loss: 1.5964
Epoch 18/50
530/530 2s 3ms/step - accuracy: 0.3835 - loss: 1.9519 - val_accuracy: 0.5040 - val_loss: 1.5847
Epoch 19/50
530/530 3s 3ms/step - accuracy: 0.3790 - loss: 1.9564 - val_accuracy: 0.4880 - val_loss: 1.5959
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.3847 - loss: 1.9356 - val_accuracy: 0.4870 - val_loss: 1.5785
Epoch 21/50
530/530 2s 3ms/step - accuracy: 0.3861 - loss: 1.9282 - val_accuracy: 0.4950 - val_loss: 1.5748
Epoch 22/50
530/530 2s 3ms/step - accuracy: 0.3881 - loss: 1.9257 - val_accuracy: 0.5020 - val_loss: 1.5707
Epoch 23/50
530/530 3s 5ms/step - accuracy: 0.3957 - loss: 1.9367 - val_accuracy: 0.5050 - val_loss: 1.5563
Epoch 24/50
530/530 2s 3ms/step - accuracy: 0.3965 - loss: 1.9160 - val_accuracy: 0.5000 - val_loss: 1.5606
Epoch 25/50
530/530 3s 3ms/step - accuracy: 0.3982 - loss: 1.8990 - val_accuracy: 0.5110 - val_loss: 1.5554
Epoch 26/50
530/530 3s 3ms/step - accuracy: 0.3946 - loss: 1.9259 - val_accuracy: 0.4970 - val_loss: 1.5474
Epoch 27/50
530/530 2s 3ms/step - accuracy: 0.3938 - loss: 1.9232 - val_accuracy: 0.5120 - val_loss: 1.5549

```
Epoch 28/50
530/530 2s 4ms/step - accuracy: 0.3943 - loss: 1.9179 - val_accuracy: 0.5270 - val_loss: 1.5394
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.4058 - loss: 1.9104 - val_accuracy: 0.5190 - val_loss: 1.5432
Epoch 30/50
530/530 2s 4ms/step - accuracy: 0.3979 - loss: 1.9106 - val_accuracy: 0.5050 - val_loss: 1.5475
Epoch 31/50
530/530 2s 3ms/step - accuracy: 0.3953 - loss: 1.9214 - val_accuracy: 0.5190 - val_loss: 1.5238
Epoch 32/50
530/530 2s 3ms/step - accuracy: 0.4036 - loss: 1.8932 - val_accuracy: 0.5060 - val_loss: 1.5217
Epoch 33/50
530/530 3s 3ms/step - accuracy: 0.3995 - loss: 1.8997 - val_accuracy: 0.5270 - val_loss: 1.5295
Epoch 34/50
530/530 3s 4ms/step - accuracy: 0.4097 - loss: 1.8928 - val_accuracy: 0.5260 - val_loss: 1.5147
Epoch 35/50
530/530 3s 5ms/step - accuracy: 0.4115 - loss: 1.8829 - val_accuracy: 0.5170 - val_loss: 1.5158
Epoch 36/50
530/530 2s 3ms/step - accuracy: 0.4023 - loss: 1.8896 - val_accuracy: 0.5340 - val_loss: 1.5295
Epoch 37/50
530/530 3s 3ms/step - accuracy: 0.4054 - loss: 1.8669 - val_accuracy: 0.5120 - val_loss: 1.5122
Epoch 38/50
530/530 2s 3ms/step - accuracy: 0.4052 - loss: 1.8985 - val_accuracy: 0.5150 - val_loss: 1.5095
Epoch 39/50
530/530 3s 3ms/step - accuracy: 0.4026 - loss: 1.8832 - val_accuracy: 0.5050 - val_loss: 1.5220
Epoch 40/50
530/530 2s 4ms/step - accuracy: 0.4021 - loss: 1.8806 - val_accuracy: 0.5220 - val_loss: 1.5176
Epoch 41/50
530/530 3s 5ms/step - accuracy: 0.4032 - loss: 1.8687 - val_accuracy: 0.5330 - val_loss: 1.5070
Epoch 42/50
530/530 4s 3ms/step - accuracy: 0.4121 - loss: 1.8787 - val_accuracy: 0.5310 - val_loss: 1.5143
Epoch 43/50
530/530 2s 3ms/step - accuracy: 0.4118 - loss: 1.8720 - val_accuracy: 0.5140 - val_loss: 1.5114
Epoch 44/50
530/530 2s 3ms/step - accuracy: 0.4159 - loss: 1.8825 - val_accuracy: 0.5230 - val_loss: 1.4943
Epoch 45/50
530/530 2s 3ms/step - accuracy: 0.4093 - loss: 1.8807 - val_accuracy: 0.5210 - val_loss: 1.5199
Epoch 46/50
530/530 2s 4ms/step - accuracy: 0.4135 - loss: 1.8721 - val_accuracy: 0.5200 - val_loss: 1.5102
Epoch 47/50
530/530 3s 5ms/step - accuracy: 0.4120 - loss: 1.8814 - val_accuracy: 0.5230 - val_loss: 1.4820
Epoch 48/50
530/530 2s 3ms/step - accuracy: 0.4061 - loss: 1.8726 - val_accuracy: 0.5110 - val_loss: 1.5068
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.4073 - loss: 1.8895 - val_accuracy: 0.5140 - val_loss: 1.5039
Epoch 50/50
530/530 2s 3ms/step - accuracy: 0.4055 - loss: 1.8884 - val_accuracy: 0.5100 - val_loss: 1.5018
Accuracy: 0.5335
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_15"

Layer (type)	Output Shape	Param #
dense_66 (Dense)	(None, 32)	352
batch_normalization_51 (BatchNormalization)	(None, 32)	128
dropout_51 (Dropout)	(None, 32)	0
dense_67 (Dense)	(None, 64)	2,112
batch_normalization_52 (BatchNormalization)	(None, 64)	256
dropout_52 (Dropout)	(None, 64)	0
dense_68 (Dense)	(None, 32)	2,080
batch_normalization_53 (BatchNormalization)	(None, 32)	128
dropout_53 (Dropout)	(None, 32)	0
dense_69 (Dense)	(None, 16)	528
batch_normalization_54 (BatchNormalization)	(None, 16)	64
dropout_54 (Dropout)	(None, 16)	0
dense_70 (Dense)	(None, 32)	544
batch_normalization_55 (BatchNormalization)	(None, 32)	128
dropout_55 (Dropout)	(None, 32)	0
dense_71 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 6s 7ms/step - accuracy: 0.1526 - loss: 3.2465 - val_accuracy: 0.4210 - val_loss: 2.2212
Epoch 2/50
265/265 2s 3ms/step - accuracy: 0.3418 - loss: 2.3274 - val_accuracy: 0.5030 - val_loss: 1.8427
Epoch 3/50
265/265 1s 4ms/step - accuracy: 0.4129 - loss: 2.0592 - val_accuracy: 0.5220 - val_loss: 1.6936
Epoch 4/50
265/265 1s 3ms/step - accuracy: 0.4421 - loss: 1.9251 - val_accuracy: 0.5310 - val_loss: 1.6186
Epoch 5/50
265/265 1s 3ms/step - accuracy: 0.4697 - loss: 1.8221 - val_accuracy: 0.5520 - val_loss: 1.5512
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.4760 - loss: 1.7814 - val_accuracy: 0.5620 - val_loss: 1.5109
Epoch 7/50
265/265 1s 3ms/step - accuracy: 0.4797 - loss: 1.7375 - val_accuracy: 0.5620 - val_loss: 1.4833
Epoch 8/50
265/265 1s 4ms/step - accuracy: 0.4928 - loss: 1.7032 - val_accuracy: 0.5730 - val_loss: 1.4616
Epoch 9/50
265/265 1s 3ms/step - accuracy: 0.4937 - loss: 1.6667 - val_accuracy: 0.5680 - val_loss: 1.4327
Epoch 10/50
265/265 1s 4ms/step - accuracy: 0.4880 - loss: 1.6706 - val_accuracy: 0.5660 - val_loss: 1.4150
Epoch 11/50
265/265 1s 4ms/step - accuracy: 0.5053 - loss: 1.6289 - val_accuracy: 0.5690 - val_loss: 1.3976
Epoch 12/50
265/265 1s 5ms/step - accuracy: 0.5075 - loss: 1.6145 - val_accuracy: 0.5720 - val_loss: 1.3887
Epoch 13/50
265/265 2s 3ms/step - accuracy: 0.5058 - loss: 1.6078 - val_accuracy: 0.5880 - val_loss: 1.3756
Epoch 14/50
265/265 1s 3ms/step - accuracy: 0.5138 - loss: 1.5922 - val_accuracy: 0.5560 - val_loss: 1.3739
Epoch 15/50
265/265 1s 3ms/step - accuracy: 0.5105 - loss: 1.5930 - val_accuracy: 0.5860 - val_loss: 1.3387
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.5096 - loss: 1.5796 - val_accuracy: 0.5750 - val_loss: 1.3423
Epoch 17/50
265/265 1s 3ms/step - accuracy: 0.5204 - loss: 1.5708 - val_accuracy: 0.5820 - val_loss: 1.3390
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.5140 - loss: 1.5658 - val_accuracy: 0.5720 - val_loss: 1.3363
Epoch 19/50
265/265 1s 3ms/step - accuracy: 0.5152 - loss: 1.5509 - val_accuracy: 0.5900 - val_loss: 1.3311
Epoch 20/50
265/265 1s 3ms/step - accuracy: 0.5179 - loss: 1.5448 - val_accuracy: 0.5880 - val_loss: 1.3120
Epoch 21/50
265/265 1s 4ms/step - accuracy: 0.5256 - loss: 1.5297 - val_accuracy: 0.5890 - val_loss: 1.3089
Epoch 22/50
265/265 1s 5ms/step - accuracy: 0.5030 - loss: 1.5681 - val_accuracy: 0.5850 - val_loss: 1.3088
Epoch 23/50
265/265 1s 5ms/step - accuracy: 0.5262 - loss: 1.5245 - val_accuracy: 0.5850 - val_loss: 1.3067
Epoch 24/50
265/265 1s 5ms/step - accuracy: 0.5179 - loss: 1.5333 - val_accuracy: 0.5940 - val_loss: 1.3065
Epoch 25/50
265/265 2s 3ms/step - accuracy: 0.5346 - loss: 1.5026 - val_accuracy: 0.6020 - val_loss: 1.2902
Epoch 26/50
265/265 1s 3ms/step - accuracy: 0.5319 - loss: 1.5058 - val_accuracy: 0.5930 - val_loss: 1.2858
Epoch 27/50
265/265 1s 3ms/step - accuracy: 0.5261 - loss: 1.5168 - val_accuracy: 0.6100 - val_loss: 1.2744

```
Epoch 28/50
265/265 1s 3ms/step - accuracy: 0.5383 - loss: 1.4835 - val_accuracy: 0.6050 - val_loss: 1.2702
Epoch 29/50
265/265 1s 4ms/step - accuracy: 0.5297 - loss: 1.5024 - val_accuracy: 0.5950 - val_loss: 1.2743
Epoch 30/50
265/265 1s 4ms/step - accuracy: 0.5284 - loss: 1.4919 - val_accuracy: 0.5990 - val_loss: 1.2883
Epoch 31/50
265/265 1s 3ms/step - accuracy: 0.5258 - loss: 1.4979 - val_accuracy: 0.6070 - val_loss: 1.2710
Epoch 32/50
265/265 1s 3ms/step - accuracy: 0.5231 - loss: 1.5000 - val_accuracy: 0.6030 - val_loss: 1.2664
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.5372 - loss: 1.4927 - val_accuracy: 0.6000 - val_loss: 1.2739
Epoch 34/50
265/265 1s 5ms/step - accuracy: 0.5364 - loss: 1.4784 - val_accuracy: 0.6060 - val_loss: 1.2585
Epoch 35/50
265/265 2s 6ms/step - accuracy: 0.5406 - loss: 1.4627 - val_accuracy: 0.6030 - val_loss: 1.2561
Epoch 36/50
265/265 2s 3ms/step - accuracy: 0.5364 - loss: 1.4813 - val_accuracy: 0.6110 - val_loss: 1.2510
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.5339 - loss: 1.4883 - val_accuracy: 0.6140 - val_loss: 1.2457
Epoch 38/50
265/265 1s 3ms/step - accuracy: 0.5347 - loss: 1.4799 - val_accuracy: 0.6090 - val_loss: 1.2360
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.5393 - loss: 1.4630 - val_accuracy: 0.6040 - val_loss: 1.2499
Epoch 40/50
265/265 1s 4ms/step - accuracy: 0.5376 - loss: 1.4648 - val_accuracy: 0.6130 - val_loss: 1.2423
Epoch 41/50
265/265 1s 3ms/step - accuracy: 0.5381 - loss: 1.4660 - val_accuracy: 0.6120 - val_loss: 1.2497
Epoch 42/50
265/265 1s 3ms/step - accuracy: 0.5327 - loss: 1.4832 - val_accuracy: 0.6040 - val_loss: 1.2431
Epoch 43/50
265/265 1s 4ms/step - accuracy: 0.5329 - loss: 1.4675 - val_accuracy: 0.5960 - val_loss: 1.2356
Epoch 44/50
265/265 1s 5ms/step - accuracy: 0.5374 - loss: 1.4689 - val_accuracy: 0.5980 - val_loss: 1.2455
Epoch 45/50
265/265 1s 5ms/step - accuracy: 0.5332 - loss: 1.4700 - val_accuracy: 0.6050 - val_loss: 1.2322
Epoch 46/50
265/265 1s 5ms/step - accuracy: 0.5461 - loss: 1.4451 - val_accuracy: 0.6050 - val_loss: 1.2404
Epoch 47/50
265/265 2s 4ms/step - accuracy: 0.5404 - loss: 1.4614 - val_accuracy: 0.6150 - val_loss: 1.2096
Epoch 48/50
265/265 1s 3ms/step - accuracy: 0.5543 - loss: 1.4359 - val_accuracy: 0.5980 - val_loss: 1.2318
Epoch 49/50
265/265 1s 3ms/step - accuracy: 0.5421 - loss: 1.4487 - val_accuracy: 0.6050 - val_loss: 1.2304
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.5466 - loss: 1.4390 - val_accuracy: 0.6090 - val_loss: 1.2198
Accuracy: 0.6040
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_16"

Layer (type)	Output Shape	Param #
dense_72 (Dense)	(None, 32)	352
batch_normalization_56 (BatchNormalization)	(None, 32)	128
dropout_56 (Dropout)	(None, 32)	0
dense_73 (Dense)	(None, 64)	2,112
batch_normalization_57 (BatchNormalization)	(None, 64)	256
dropout_57 (Dropout)	(None, 64)	0
dense_74 (Dense)	(None, 32)	2,080
batch_normalization_58 (BatchNormalization)	(None, 32)	128
dropout_58 (Dropout)	(None, 32)	0
dense_75 (Dense)	(None, 16)	528
batch_normalization_59 (BatchNormalization)	(None, 16)	64
dropout_59 (Dropout)	(None, 16)	0
dense_76 (Dense)	(None, 32)	544
batch_normalization_60 (BatchNormalization)	(None, 32)	128
dropout_60 (Dropout)	(None, 32)	0
dense_77 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 7s 7ms/step - accuracy: 0.1087 - loss: 3.4148 - val_accuracy: 0.3770 - val_loss: 2.3422
Epoch 2/50
265/265 2s 4ms/step - accuracy: 0.2675 - loss: 2.5476 - val_accuracy: 0.4360 - val_loss: 2.0126
Epoch 3/50
265/265 1s 4ms/step - accuracy: 0.3304 - loss: 2.2788 - val_accuracy: 0.4900 - val_loss: 1.8436
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.3590 - loss: 2.1385 - val_accuracy: 0.5010 - val_loss: 1.7534
Epoch 5/50
265/265 1s 3ms/step - accuracy: 0.3876 - loss: 2.0366 - val_accuracy: 0.5030 - val_loss: 1.6913
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.3962 - loss: 1.9705 - val_accuracy: 0.5050 - val_loss: 1.6440
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.4091 - loss: 1.9502 - val_accuracy: 0.5230 - val_loss: 1.6051
Epoch 8/50
265/265 1s 4ms/step - accuracy: 0.4262 - loss: 1.8945 - val_accuracy: 0.5180 - val_loss: 1.5825
Epoch 9/50
265/265 1s 4ms/step - accuracy: 0.4311 - loss: 1.8761 - val_accuracy: 0.5440 - val_loss: 1.5432
Epoch 10/50
265/265 1s 5ms/step - accuracy: 0.4365 - loss: 1.8515 - val_accuracy: 0.5380 - val_loss: 1.5267
Epoch 11/50
265/265 3s 5ms/step - accuracy: 0.4453 - loss: 1.8291 - val_accuracy: 0.5410 - val_loss: 1.5254
Epoch 12/50
265/265 2s 3ms/step - accuracy: 0.4445 - loss: 1.8106 - val_accuracy: 0.5340 - val_loss: 1.5079
Epoch 13/50
265/265 1s 4ms/step - accuracy: 0.4258 - loss: 1.8300 - val_accuracy: 0.5380 - val_loss: 1.4944
Epoch 14/50
265/265 1s 3ms/step - accuracy: 0.4418 - loss: 1.8096 - val_accuracy: 0.5490 - val_loss: 1.4744
Epoch 15/50
265/265 1s 4ms/step - accuracy: 0.4548 - loss: 1.7678 - val_accuracy: 0.5490 - val_loss: 1.4691
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.4440 - loss: 1.7803 - val_accuracy: 0.5400 - val_loss: 1.4631
Epoch 17/50
265/265 1s 4ms/step - accuracy: 0.4473 - loss: 1.7648 - val_accuracy: 0.5430 - val_loss: 1.4615
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.4506 - loss: 1.7707 - val_accuracy: 0.5490 - val_loss: 1.4513
Epoch 19/50
265/265 1s 4ms/step - accuracy: 0.4612 - loss: 1.7255 - val_accuracy: 0.5480 - val_loss: 1.4422
Epoch 20/50
265/265 2s 5ms/step - accuracy: 0.4564 - loss: 1.7536 - val_accuracy: 0.5510 - val_loss: 1.4414
Epoch 21/50
265/265 2s 4ms/step - accuracy: 0.4575 - loss: 1.7342 - val_accuracy: 0.5670 - val_loss: 1.4311
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.4530 - loss: 1.7320 - val_accuracy: 0.5530 - val_loss: 1.4303
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.4671 - loss: 1.7297 - val_accuracy: 0.5420 - val_loss: 1.4411
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.4594 - loss: 1.7280 - val_accuracy: 0.5640 - val_loss: 1.4086
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.4726 - loss: 1.7143 - val_accuracy: 0.5640 - val_loss: 1.4110
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.4641 - loss: 1.7201 - val_accuracy: 0.5500 - val_loss: 1.4059
Epoch 27/50
265/265 1s 4ms/step - accuracy: 0.4660 - loss: 1.7228 - val_accuracy: 0.5700 - val_loss: 1.4009

```
Epoch 28/50
265/265 1s 4ms/step - accuracy: 0.4641 - loss: 1.6975 - val_accuracy: 0.5620 - val_loss: 1.3919
Epoch 29/50
265/265 1s 3ms/step - accuracy: 0.4730 - loss: 1.6837 - val_accuracy: 0.5500 - val_loss: 1.3908
Epoch 30/50
265/265 2s 5ms/step - accuracy: 0.4598 - loss: 1.7138 - val_accuracy: 0.5590 - val_loss: 1.3905
Epoch 31/50
265/265 3s 5ms/step - accuracy: 0.4697 - loss: 1.7008 - val_accuracy: 0.5680 - val_loss: 1.3847
Epoch 32/50
265/265 1s 4ms/step - accuracy: 0.4684 - loss: 1.7012 - val_accuracy: 0.5740 - val_loss: 1.3766
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.4761 - loss: 1.6828 - val_accuracy: 0.5750 - val_loss: 1.3740
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.4653 - loss: 1.6984 - val_accuracy: 0.5670 - val_loss: 1.3610
Epoch 35/50
265/265 1s 4ms/step - accuracy: 0.4703 - loss: 1.6768 - val_accuracy: 0.5740 - val_loss: 1.3636
Epoch 36/50
265/265 1s 4ms/step - accuracy: 0.4658 - loss: 1.7037 - val_accuracy: 0.5590 - val_loss: 1.3764
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.4727 - loss: 1.6802 - val_accuracy: 0.5490 - val_loss: 1.3745
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.4807 - loss: 1.6589 - val_accuracy: 0.5730 - val_loss: 1.3699
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.4819 - loss: 1.6623 - val_accuracy: 0.5660 - val_loss: 1.3590
Epoch 40/50
265/265 2s 5ms/step - accuracy: 0.4753 - loss: 1.6728 - val_accuracy: 0.5820 - val_loss: 1.3521
Epoch 41/50
265/265 2s 6ms/step - accuracy: 0.4771 - loss: 1.6648 - val_accuracy: 0.5860 - val_loss: 1.3432
Epoch 42/50
265/265 2s 6ms/step - accuracy: 0.4804 - loss: 1.6653 - val_accuracy: 0.5700 - val_loss: 1.3514
Epoch 43/50
265/265 1s 3ms/step - accuracy: 0.4777 - loss: 1.6649 - val_accuracy: 0.5840 - val_loss: 1.3469
Epoch 44/50
265/265 1s 4ms/step - accuracy: 0.4747 - loss: 1.6575 - val_accuracy: 0.5840 - val_loss: 1.3426
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.4708 - loss: 1.6833 - val_accuracy: 0.5760 - val_loss: 1.3515
Epoch 46/50
265/265 1s 4ms/step - accuracy: 0.4848 - loss: 1.6399 - val_accuracy: 0.5750 - val_loss: 1.3410
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.4754 - loss: 1.6596 - val_accuracy: 0.5660 - val_loss: 1.3354
Epoch 48/50
265/265 1s 4ms/step - accuracy: 0.4824 - loss: 1.6548 - val_accuracy: 0.5770 - val_loss: 1.3406
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.4724 - loss: 1.6571 - val_accuracy: 0.5780 - val_loss: 1.3303
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.4958 - loss: 1.6334 - val_accuracy: 0.5750 - val_loss: 1.3312
Accuracy: 0.5760
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_17"

Layer (type)	Output Shape	Param #
dense_78 (Dense)	(None, 32)	352
batch_normalization_61 (BatchNormalization)	(None, 32)	128
dropout_61 (Dropout)	(None, 32)	0
dense_79 (Dense)	(None, 64)	2,112
batch_normalization_62 (BatchNormalization)	(None, 64)	256
dropout_62 (Dropout)	(None, 64)	0
dense_80 (Dense)	(None, 32)	2,080
batch_normalization_63 (BatchNormalization)	(None, 32)	128
dropout_63 (Dropout)	(None, 32)	0
dense_81 (Dense)	(None, 16)	528
batch_normalization_64 (BatchNormalization)	(None, 16)	64
dropout_64 (Dropout)	(None, 16)	0
dense_82 (Dense)	(None, 32)	544
batch_normalization_65 (BatchNormalization)	(None, 32)	128
dropout_65 (Dropout)	(None, 32)	0
dense_83 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 6s 5ms/step - accuracy: 0.0885 - loss: 3.5926 - val_accuracy: 0.3470 - val_loss: 2.5711
Epoch 2/50
265/265 2s 4ms/step - accuracy: 0.1887 - loss: 2.7979 - val_accuracy: 0.4050 - val_loss: 2.2326
Epoch 3/50
265/265 1s 3ms/step - accuracy: 0.2444 - loss: 2.5173 - val_accuracy: 0.4110 - val_loss: 2.0707
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.2846 - loss: 2.3594 - val_accuracy: 0.4240 - val_loss: 1.9597
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.3081 - loss: 2.2377 - val_accuracy: 0.4440 - val_loss: 1.8785
Epoch 6/50
265/265 1s 3ms/step - accuracy: 0.3217 - loss: 2.1771 - val_accuracy: 0.4430 - val_loss: 1.8194
Epoch 7/50
265/265 1s 3ms/step - accuracy: 0.3174 - loss: 2.1667 - val_accuracy: 0.4490 - val_loss: 1.7673
Epoch 8/50
265/265 2s 5ms/step - accuracy: 0.3459 - loss: 2.0899 - val_accuracy: 0.4750 - val_loss: 1.7423
Epoch 9/50
265/265 2s 6ms/step - accuracy: 0.3449 - loss: 2.0859 - val_accuracy: 0.4780 - val_loss: 1.7126
Epoch 10/50
265/265 2s 3ms/step - accuracy: 0.3547 - loss: 2.0476 - val_accuracy: 0.4770 - val_loss: 1.6932
Epoch 11/50
265/265 1s 4ms/step - accuracy: 0.3597 - loss: 2.0409 - val_accuracy: 0.4810 - val_loss: 1.6883
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.3640 - loss: 2.0106 - val_accuracy: 0.4890 - val_loss: 1.6627
Epoch 13/50
265/265 1s 4ms/step - accuracy: 0.3670 - loss: 2.0021 - val_accuracy: 0.4970 - val_loss: 1.6410
Epoch 14/50
265/265 1s 4ms/step - accuracy: 0.3758 - loss: 1.9585 - val_accuracy: 0.5000 - val_loss: 1.6306
Epoch 15/50
265/265 1s 4ms/step - accuracy: 0.3706 - loss: 1.9775 - val_accuracy: 0.4930 - val_loss: 1.6147
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.3816 - loss: 1.9487 - val_accuracy: 0.5010 - val_loss: 1.6073
Epoch 17/50
265/265 1s 3ms/step - accuracy: 0.3960 - loss: 1.9303 - val_accuracy: 0.4950 - val_loss: 1.5926
Epoch 18/50
265/265 1s 5ms/step - accuracy: 0.3817 - loss: 1.9329 - val_accuracy: 0.5120 - val_loss: 1.5857
Epoch 19/50
265/265 1s 5ms/step - accuracy: 0.3825 - loss: 1.9437 - val_accuracy: 0.5010 - val_loss: 1.5829
Epoch 20/50
265/265 1s 5ms/step - accuracy: 0.3858 - loss: 1.9318 - val_accuracy: 0.5090 - val_loss: 1.5768
Epoch 21/50
265/265 1s 3ms/step - accuracy: 0.3937 - loss: 1.9324 - val_accuracy: 0.5050 - val_loss: 1.5755
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.3902 - loss: 1.9223 - val_accuracy: 0.4930 - val_loss: 1.5711
Epoch 23/50
265/265 1s 3ms/step - accuracy: 0.3948 - loss: 1.9134 - val_accuracy: 0.5110 - val_loss: 1.5618
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.3940 - loss: 1.8951 - val_accuracy: 0.5210 - val_loss: 1.5471
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.4028 - loss: 1.8935 - val_accuracy: 0.5070 - val_loss: 1.5454
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.4042 - loss: 1.8850 - val_accuracy: 0.5220 - val_loss: 1.5318
Epoch 27/50
265/265 1s 4ms/step - accuracy: 0.4067 - loss: 1.8961 - val_accuracy: 0.5160 - val_loss: 1.5389

```
Epoch 28/50
265/265 1s 4ms/step - accuracy: 0.4054 - loss: 1.8833 - val_accuracy: 0.5220 - val_loss: 1.5406
Epoch 29/50
265/265 2s 5ms/step - accuracy: 0.4040 - loss: 1.8829 - val_accuracy: 0.5160 - val_loss: 1.5248
Epoch 30/50
265/265 2s 4ms/step - accuracy: 0.4105 - loss: 1.8556 - val_accuracy: 0.5270 - val_loss: 1.5318
Epoch 31/50
265/265 1s 4ms/step - accuracy: 0.4155 - loss: 1.8642 - val_accuracy: 0.5330 - val_loss: 1.5216
Epoch 32/50
265/265 1s 4ms/step - accuracy: 0.4134 - loss: 1.8698 - val_accuracy: 0.5180 - val_loss: 1.5220
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.4162 - loss: 1.8522 - val_accuracy: 0.5190 - val_loss: 1.5138
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.4157 - loss: 1.8526 - val_accuracy: 0.5330 - val_loss: 1.5207
Epoch 35/50
265/265 1s 4ms/step - accuracy: 0.4164 - loss: 1.8455 - val_accuracy: 0.5300 - val_loss: 1.5060
Epoch 36/50
265/265 1s 4ms/step - accuracy: 0.4193 - loss: 1.8613 - val_accuracy: 0.5360 - val_loss: 1.5131
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.4213 - loss: 1.8466 - val_accuracy: 0.5350 - val_loss: 1.4955
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.4060 - loss: 1.8542 - val_accuracy: 0.5270 - val_loss: 1.4872
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.4224 - loss: 1.8457 - val_accuracy: 0.5070 - val_loss: 1.4993
Epoch 40/50
265/265 1s 5ms/step - accuracy: 0.4198 - loss: 1.8366 - val_accuracy: 0.5200 - val_loss: 1.4867
Epoch 41/50
265/265 2s 6ms/step - accuracy: 0.4173 - loss: 1.8581 - val_accuracy: 0.5250 - val_loss: 1.4912
Epoch 42/50
265/265 2s 4ms/step - accuracy: 0.4266 - loss: 1.8325 - val_accuracy: 0.5270 - val_loss: 1.4954
Epoch 43/50
265/265 1s 4ms/step - accuracy: 0.4210 - loss: 1.8393 - val_accuracy: 0.5340 - val_loss: 1.4938
Epoch 44/50
265/265 1s 4ms/step - accuracy: 0.4210 - loss: 1.8448 - val_accuracy: 0.5310 - val_loss: 1.4770
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.4245 - loss: 1.8364 - val_accuracy: 0.5240 - val_loss: 1.4789
Epoch 46/50
265/265 1s 4ms/step - accuracy: 0.4221 - loss: 1.8251 - val_accuracy: 0.5390 - val_loss: 1.4816
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.4268 - loss: 1.8189 - val_accuracy: 0.5250 - val_loss: 1.4778
Epoch 48/50
265/265 1s 4ms/step - accuracy: 0.4223 - loss: 1.8365 - val_accuracy: 0.5320 - val_loss: 1.4700
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.4216 - loss: 1.8317 - val_accuracy: 0.5360 - val_loss: 1.4732
Epoch 50/50
265/265 1s 5ms/step - accuracy: 0.4239 - loss: 1.8183 - val_accuracy: 0.5370 - val_loss: 1.4758
Accuracy: 0.5450
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_18"

Layer (type)	Output Shape	Param #
dense_84 (Dense)	(None, 32)	352
batch_normalization_66 (BatchNormalization)	(None, 32)	128
dropout_66 (Dropout)	(None, 32)	0
dense_85 (Dense)	(None, 64)	2,112
batch_normalization_67 (BatchNormalization)	(None, 64)	256
dropout_67 (Dropout)	(None, 64)	0
dense_86 (Dense)	(None, 32)	2,080
batch_normalization_68 (BatchNormalization)	(None, 32)	128
dropout_68 (Dropout)	(None, 32)	0
dense_87 (Dense)	(None, 16)	528
batch_normalization_69 (BatchNormalization)	(None, 16)	64
dropout_69 (Dropout)	(None, 16)	0
dense_88 (Dense)	(None, 32)	544
batch_normalization_70 (BatchNormalization)	(None, 32)	128
dropout_70 (Dropout)	(None, 32)	0
dense_89 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 7s 4ms/step - accuracy: 0.3016 - loss: 2.4531 - val_accuracy: 0.4510 - val_loss: 1.7561
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.4129 - loss: 1.9578 - val_accuracy: 0.5080 - val_loss: 1.6296
Epoch 3/50
530/530 3s 3ms/step - accuracy: 0.4339 - loss: 1.8939 - val_accuracy: 0.4950 - val_loss: 1.6867
Epoch 4/50
530/530 3s 4ms/step - accuracy: 0.4489 - loss: 1.8600 - val_accuracy: 0.5050 - val_loss: 1.6738
Epoch 5/50
530/530 3s 5ms/step - accuracy: 0.4326 - loss: 1.8810 - val_accuracy: 0.4980 - val_loss: 1.6693
Epoch 6/50
530/530 2s 3ms/step - accuracy: 0.4374 - loss: 1.8523 - val_accuracy: 0.5090 - val_loss: 1.6183
Epoch 7/50
530/530 2s 3ms/step - accuracy: 0.4498 - loss: 1.8305 - val_accuracy: 0.5180 - val_loss: 1.6048
Epoch 8/50
530/530 3s 3ms/step - accuracy: 0.4586 - loss: 1.8163 - val_accuracy: 0.5290 - val_loss: 1.6116
Epoch 9/50
530/530 3s 3ms/step - accuracy: 0.4581 - loss: 1.8291 - val_accuracy: 0.5110 - val_loss: 1.6391
Epoch 10/50
530/530 2s 4ms/step - accuracy: 0.4562 - loss: 1.8195 - val_accuracy: 0.5190 - val_loss: 1.5747
Epoch 11/50
530/530 3s 5ms/step - accuracy: 0.4521 - loss: 1.8299 - val_accuracy: 0.5320 - val_loss: 1.5630
Epoch 12/50
530/530 2s 4ms/step - accuracy: 0.4665 - loss: 1.7856 - val_accuracy: 0.5390 - val_loss: 1.5802
Epoch 13/50
530/530 2s 3ms/step - accuracy: 0.4564 - loss: 1.8062 - val_accuracy: 0.5380 - val_loss: 1.5359
Epoch 14/50
530/530 3s 3ms/step - accuracy: 0.4650 - loss: 1.8030 - val_accuracy: 0.5120 - val_loss: 1.5999
Epoch 15/50
530/530 3s 3ms/step - accuracy: 0.4652 - loss: 1.8044 - val_accuracy: 0.5220 - val_loss: 1.5927
Epoch 16/50
530/530 3s 4ms/step - accuracy: 0.4557 - loss: 1.8051 - val_accuracy: 0.5120 - val_loss: 1.5640
Epoch 17/50
530/530 3s 5ms/step - accuracy: 0.4604 - loss: 1.8004 - val_accuracy: 0.5360 - val_loss: 1.5530
Epoch 18/50
530/530 2s 4ms/step - accuracy: 0.4721 - loss: 1.7704 - val_accuracy: 0.5530 - val_loss: 1.5421
Epoch 19/50
530/530 2s 3ms/step - accuracy: 0.4743 - loss: 1.7658 - val_accuracy: 0.5190 - val_loss: 1.5873
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.4642 - loss: 1.7862 - val_accuracy: 0.5680 - val_loss: 1.5026
Epoch 21/50
530/530 2s 3ms/step - accuracy: 0.4617 - loss: 1.8121 - val_accuracy: 0.5320 - val_loss: 1.5468
Epoch 22/50
530/530 3s 3ms/step - accuracy: 0.4704 - loss: 1.7828 - val_accuracy: 0.5210 - val_loss: 1.5963
Epoch 23/50
530/530 2s 4ms/step - accuracy: 0.4671 - loss: 1.7790 - val_accuracy: 0.5470 - val_loss: 1.5177
Epoch 24/50
530/530 3s 5ms/step - accuracy: 0.4824 - loss: 1.7498 - val_accuracy: 0.5290 - val_loss: 1.5597
Epoch 25/50
530/530 4s 3ms/step - accuracy: 0.4697 - loss: 1.7681 - val_accuracy: 0.5440 - val_loss: 1.5155
Epoch 26/50
530/530 2s 3ms/step - accuracy: 0.4809 - loss: 1.7471 - val_accuracy: 0.5480 - val_loss: 1.5197
Epoch 27/50
530/530 2s 3ms/step - accuracy: 0.4663 - loss: 1.7984 - val_accuracy: 0.5290 - val_loss: 1.5564

```
Epoch 28/50
530/530 3s 4ms/step - accuracy: 0.4735 - loss: 1.7728 - val_accuracy: 0.5450 - val_loss: 1.5360
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.4724 - loss: 1.7507 - val_accuracy: 0.5310 - val_loss: 1.5894
Epoch 30/50
530/530 2s 3ms/step - accuracy: 0.4764 - loss: 1.7615 - val_accuracy: 0.5520 - val_loss: 1.5227
Epoch 31/50
530/530 2s 3ms/step - accuracy: 0.4766 - loss: 1.7818 - val_accuracy: 0.5560 - val_loss: 1.4908
Epoch 32/50
530/530 2s 3ms/step - accuracy: 0.4807 - loss: 1.7683 - val_accuracy: 0.5360 - val_loss: 1.5476
Epoch 33/50
530/530 3s 3ms/step - accuracy: 0.4866 - loss: 1.7438 - val_accuracy: 0.5170 - val_loss: 1.5479
Epoch 34/50
530/530 3s 4ms/step - accuracy: 0.4839 - loss: 1.7395 - val_accuracy: 0.5430 - val_loss: 1.5663
Epoch 35/50
530/530 3s 5ms/step - accuracy: 0.4769 - loss: 1.7680 - val_accuracy: 0.5430 - val_loss: 1.5407
Epoch 36/50
530/530 4s 3ms/step - accuracy: 0.4785 - loss: 1.7465 - val_accuracy: 0.5330 - val_loss: 1.5527
Epoch 37/50
530/530 3s 3ms/step - accuracy: 0.4707 - loss: 1.7734 - val_accuracy: 0.5600 - val_loss: 1.4829
Epoch 38/50
530/530 3s 3ms/step - accuracy: 0.4803 - loss: 1.7418 - val_accuracy: 0.5280 - val_loss: 1.5610
Epoch 39/50
530/530 3s 5ms/step - accuracy: 0.4786 - loss: 1.7602 - val_accuracy: 0.5470 - val_loss: 1.5185
Epoch 40/50
530/530 3s 5ms/step - accuracy: 0.4757 - loss: 1.7582 - val_accuracy: 0.5680 - val_loss: 1.4763
Epoch 41/50
530/530 2s 3ms/step - accuracy: 0.4818 - loss: 1.7374 - val_accuracy: 0.5630 - val_loss: 1.5108
Epoch 42/50
530/530 3s 3ms/step - accuracy: 0.4800 - loss: 1.7497 - val_accuracy: 0.5390 - val_loss: 1.5169
Epoch 43/50
530/530 2s 3ms/step - accuracy: 0.4822 - loss: 1.7521 - val_accuracy: 0.5550 - val_loss: 1.4953
Epoch 44/50
530/530 2s 3ms/step - accuracy: 0.4747 - loss: 1.7566 - val_accuracy: 0.5350 - val_loss: 1.4961
Epoch 45/50
530/530 3s 4ms/step - accuracy: 0.4666 - loss: 1.7764 - val_accuracy: 0.5520 - val_loss: 1.5006
Epoch 46/50
530/530 3s 5ms/step - accuracy: 0.4867 - loss: 1.7337 - val_accuracy: 0.5490 - val_loss: 1.5016
Epoch 47/50
530/530 4s 3ms/step - accuracy: 0.4777 - loss: 1.7585 - val_accuracy: 0.5550 - val_loss: 1.4943
Epoch 48/50
530/530 3s 3ms/step - accuracy: 0.4860 - loss: 1.7344 - val_accuracy: 0.5270 - val_loss: 1.5738
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.4868 - loss: 1.7207 - val_accuracy: 0.5420 - val_loss: 1.4889
Epoch 50/50
530/530 2s 5ms/step - accuracy: 0.4877 - loss: 1.7174 - val_accuracy: 0.5590 - val_loss: 1.4976
Accuracy: 0.5460
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_19"

Layer (type)	Output Shape	Param #
dense_90 (Dense)	(None, 32)	352
batch_normalization_71 (BatchNormalization)	(None, 32)	128
dropout_71 (Dropout)	(None, 32)	0
dense_91 (Dense)	(None, 64)	2,112
batch_normalization_72 (BatchNormalization)	(None, 64)	256
dropout_72 (Dropout)	(None, 64)	0
dense_92 (Dense)	(None, 32)	2,080
batch_normalization_73 (BatchNormalization)	(None, 32)	128
dropout_73 (Dropout)	(None, 32)	0
dense_93 (Dense)	(None, 16)	528
batch_normalization_74 (BatchNormalization)	(None, 16)	64
dropout_74 (Dropout)	(None, 16)	0
dense_94 (Dense)	(None, 32)	544
batch_normalization_75 (BatchNormalization)	(None, 32)	128
dropout_75 (Dropout)	(None, 32)	0
dense_95 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 6s 4ms/step - accuracy: 0.2560 - loss: 2.5913 - val_accuracy: 0.4330 - val_loss: 1.8655
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.3518 - loss: 2.1158 - val_accuracy: 0.4730 - val_loss: 1.7731
Epoch 3/50
530/530 2s 3ms/step - accuracy: 0.3752 - loss: 2.0664 - val_accuracy: 0.4670 - val_loss: 1.7502
Epoch 4/50
530/530 2s 4ms/step - accuracy: 0.3836 - loss: 2.0380 - val_accuracy: 0.5010 - val_loss: 1.7214
Epoch 5/50
530/530 3s 5ms/step - accuracy: 0.3919 - loss: 2.0086 - val_accuracy: 0.4700 - val_loss: 1.7416
Epoch 6/50
530/530 2s 4ms/step - accuracy: 0.3911 - loss: 2.0128 - val_accuracy: 0.4640 - val_loss: 1.7582
Epoch 7/50
530/530 2s 3ms/step - accuracy: 0.3879 - loss: 2.0119 - val_accuracy: 0.4780 - val_loss: 1.7408
Epoch 8/50
530/530 3s 3ms/step - accuracy: 0.3916 - loss: 1.9995 - val_accuracy: 0.4620 - val_loss: 1.7775
Epoch 9/50
530/530 2s 3ms/step - accuracy: 0.3945 - loss: 2.0076 - val_accuracy: 0.5150 - val_loss: 1.6631
Epoch 10/50
530/530 2s 3ms/step - accuracy: 0.4090 - loss: 1.9802 - val_accuracy: 0.4990 - val_loss: 1.6532
Epoch 11/50
530/530 2s 4ms/step - accuracy: 0.4006 - loss: 1.9789 - val_accuracy: 0.4870 - val_loss: 1.7255
Epoch 12/50
530/530 3s 5ms/step - accuracy: 0.4068 - loss: 1.9821 - val_accuracy: 0.5020 - val_loss: 1.6575
Epoch 13/50
530/530 2s 3ms/step - accuracy: 0.4135 - loss: 1.9545 - val_accuracy: 0.5130 - val_loss: 1.6373
Epoch 14/50
530/530 3s 3ms/step - accuracy: 0.4088 - loss: 1.9620 - val_accuracy: 0.4750 - val_loss: 1.7108
Epoch 15/50
530/530 3s 3ms/step - accuracy: 0.4059 - loss: 1.9662 - val_accuracy: 0.5200 - val_loss: 1.6346
Epoch 16/50
530/530 2s 3ms/step - accuracy: 0.4095 - loss: 1.9705 - val_accuracy: 0.4800 - val_loss: 1.6885
Epoch 17/50
530/530 2s 4ms/step - accuracy: 0.4166 - loss: 1.9415 - val_accuracy: 0.4930 - val_loss: 1.6843
Epoch 18/50
530/530 3s 5ms/step - accuracy: 0.4199 - loss: 1.9417 - val_accuracy: 0.4890 - val_loss: 1.6584
Epoch 19/50
530/530 4s 3ms/step - accuracy: 0.4094 - loss: 1.9614 - val_accuracy: 0.5060 - val_loss: 1.6587
Epoch 20/50
530/530 3s 3ms/step - accuracy: 0.4160 - loss: 1.9546 - val_accuracy: 0.4790 - val_loss: 1.7300
Epoch 21/50
530/530 2s 3ms/step - accuracy: 0.4191 - loss: 1.9475 - val_accuracy: 0.5040 - val_loss: 1.6992
Epoch 22/50
530/530 3s 4ms/step - accuracy: 0.4217 - loss: 1.9390 - val_accuracy: 0.5280 - val_loss: 1.6152
Epoch 23/50
530/530 3s 5ms/step - accuracy: 0.4279 - loss: 1.9234 - val_accuracy: 0.5150 - val_loss: 1.6383
Epoch 24/50
530/530 2s 3ms/step - accuracy: 0.4186 - loss: 1.9374 - val_accuracy: 0.4890 - val_loss: 1.7182
Epoch 25/50
530/530 2s 3ms/step - accuracy: 0.4171 - loss: 1.9360 - val_accuracy: 0.5170 - val_loss: 1.6645
Epoch 26/50
530/530 2s 3ms/step - accuracy: 0.4254 - loss: 1.9215 - val_accuracy: 0.5020 - val_loss: 1.6632
Epoch 27/50
530/530 2s 3ms/step - accuracy: 0.4213 - loss: 1.9408 - val_accuracy: 0.4990 - val_loss: 1.6759

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Epoch 28/50
530/530 2s 3ms/step - accuracy: 0.4203 - loss: 1.9296 - val_accuracy: 0.5140 - val_loss: 1.6472
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.4331 - loss: 1.9131 - val_accuracy: 0.5140 - val_loss: 1.6434
Epoch 30/50
530/530 4s 3ms/step - accuracy: 0.4304 - loss: 1.9258 - val_accuracy: 0.4520 - val_loss: 1.7705
Epoch 31/50
530/530 3s 3ms/step - accuracy: 0.4284 - loss: 1.9310 - val_accuracy: 0.4910 - val_loss: 1.6432
Epoch 32/50
530/530 2s 3ms/step - accuracy: 0.4258 - loss: 1.9144 - val_accuracy: 0.4910 - val_loss: 1.6727
Epoch 33/50
530/530 3s 4ms/step - accuracy: 0.4216 - loss: 1.9456 - val_accuracy: 0.5140 - val_loss: 1.6891
Epoch 34/50
530/530 3s 5ms/step - accuracy: 0.4295 - loss: 1.9359 - val_accuracy: 0.5130 - val_loss: 1.6319
Epoch 35/50
530/530 2s 3ms/step - accuracy: 0.4197 - loss: 1.9311 - val_accuracy: 0.4960 - val_loss: 1.6567
Epoch 36/50
530/530 3s 3ms/step - accuracy: 0.4288 - loss: 1.9163 - val_accuracy: 0.5000 - val_loss: 1.6191
Epoch 37/50
530/530 3s 3ms/step - accuracy: 0.4224 - loss: 1.9211 - val_accuracy: 0.4990 - val_loss: 1.6086
Epoch 38/50
530/530 3s 3ms/step - accuracy: 0.4302 - loss: 1.9178 - val_accuracy: 0.5220 - val_loss: 1.6115
Epoch 39/50
530/530 3s 5ms/step - accuracy: 0.4274 - loss: 1.9233 - val_accuracy: 0.5140 - val_loss: 1.5991
Epoch 40/50
530/530 2s 4ms/step - accuracy: 0.4268 - loss: 1.9268 - val_accuracy: 0.4940 - val_loss: 1.6281
Epoch 41/50
530/530 2s 3ms/step - accuracy: 0.4234 - loss: 1.9285 - val_accuracy: 0.5320 - val_loss: 1.6254
Epoch 42/50
530/530 2s 3ms/step - accuracy: 0.4194 - loss: 1.9563 - val_accuracy: 0.5120 - val_loss: 1.6479
Epoch 43/50
530/530 2s 3ms/step - accuracy: 0.4318 - loss: 1.9367 - val_accuracy: 0.5210 - val_loss: 1.6301
Epoch 44/50
530/530 3s 3ms/step - accuracy: 0.4342 - loss: 1.9086 - val_accuracy: 0.5190 - val_loss: 1.6340
Epoch 45/50
530/530 3s 4ms/step - accuracy: 0.4319 - loss: 1.9160 - val_accuracy: 0.5120 - val_loss: 1.6186
Epoch 46/50
530/530 3s 5ms/step - accuracy: 0.4274 - loss: 1.9246 - val_accuracy: 0.5230 - val_loss: 1.6004
Epoch 47/50
530/530 4s 3ms/step - accuracy: 0.4256 - loss: 1.9227 - val_accuracy: 0.5340 - val_loss: 1.6046
Epoch 48/50
530/530 3s 3ms/step - accuracy: 0.4253 - loss: 1.9236 - val_accuracy: 0.5140 - val_loss: 1.6274
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.4276 - loss: 1.9289 - val_accuracy: 0.5100 - val_loss: 1.6090
Epoch 50/50
530/530 2s 3ms/step - accuracy: 0.4320 - loss: 1.9063 - val_accuracy: 0.5060 - val_loss: 1.6379
Accuracy: 0.4935
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_20"

Layer (type)	Output Shape	Param #
dense_96 (Dense)	(None, 32)	352
batch_normalization_76 (BatchNormalization)	(None, 32)	128
dropout_76 (Dropout)	(None, 32)	0
dense_97 (Dense)	(None, 64)	2,112
batch_normalization_77 (BatchNormalization)	(None, 64)	256
dropout_77 (Dropout)	(None, 64)	0
dense_98 (Dense)	(None, 32)	2,080
batch_normalization_78 (BatchNormalization)	(None, 32)	128
dropout_78 (Dropout)	(None, 32)	0
dense_99 (Dense)	(None, 16)	528
batch_normalization_79 (BatchNormalization)	(None, 16)	64
dropout_79 (Dropout)	(None, 16)	0
dense_100 (Dense)	(None, 32)	544
batch_normalization_80 (BatchNormalization)	(None, 32)	128
dropout_80 (Dropout)	(None, 32)	0
dense_101 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 7s 4ms/step - accuracy: 0.2062 - loss: 2.7636 - val_accuracy: 0.3640 - val_loss: 1.9408
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.2874 - loss: 2.2622 - val_accuracy: 0.3870 - val_loss: 1.9629
Epoch 3/50
530/530 2s 3ms/step - accuracy: 0.3001 - loss: 2.2265 - val_accuracy: 0.4020 - val_loss: 1.8722
Epoch 4/50
530/530 3s 4ms/step - accuracy: 0.3103 - loss: 2.2073 - val_accuracy: 0.3940 - val_loss: 1.8504
Epoch 5/50
530/530 3s 5ms/step - accuracy: 0.3130 - loss: 2.2117 - val_accuracy: 0.4280 - val_loss: 1.8256
Epoch 6/50
530/530 4s 3ms/step - accuracy: 0.3237 - loss: 2.1738 - val_accuracy: 0.4380 - val_loss: 1.8687
Epoch 7/50
530/530 3s 3ms/step - accuracy: 0.3198 - loss: 2.1756 - val_accuracy: 0.4260 - val_loss: 1.8493
Epoch 8/50
530/530 2s 3ms/step - accuracy: 0.3215 - loss: 2.1804 - val_accuracy: 0.4070 - val_loss: 1.8723
Epoch 9/50
530/530 3s 5ms/step - accuracy: 0.3295 - loss: 2.1706 - val_accuracy: 0.4440 - val_loss: 1.8105
Epoch 10/50
530/530 3s 5ms/step - accuracy: 0.3382 - loss: 2.1465 - val_accuracy: 0.4480 - val_loss: 1.7869
Epoch 11/50
530/530 2s 3ms/step - accuracy: 0.3312 - loss: 2.1652 - val_accuracy: 0.4690 - val_loss: 1.7585
Epoch 12/50
530/530 2s 3ms/step - accuracy: 0.3595 - loss: 2.1071 - val_accuracy: 0.4260 - val_loss: 1.8432
Epoch 13/50
530/530 3s 3ms/step - accuracy: 0.3449 - loss: 2.1481 - val_accuracy: 0.4810 - val_loss: 1.7903
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.3449 - loss: 2.1337 - val_accuracy: 0.4440 - val_loss: 1.8028
Epoch 15/50
530/530 3s 4ms/step - accuracy: 0.3428 - loss: 2.1355 - val_accuracy: 0.4660 - val_loss: 1.7803
Epoch 16/50
530/530 3s 5ms/step - accuracy: 0.3445 - loss: 2.1272 - val_accuracy: 0.4490 - val_loss: 1.7778
Epoch 17/50
530/530 2s 4ms/step - accuracy: 0.3457 - loss: 2.1370 - val_accuracy: 0.4630 - val_loss: 1.7768
Epoch 18/50
530/530 2s 3ms/step - accuracy: 0.3513 - loss: 2.1203 - val_accuracy: 0.4410 - val_loss: 1.8624
Epoch 19/50
530/530 2s 3ms/step - accuracy: 0.3514 - loss: 2.1271 - val_accuracy: 0.4360 - val_loss: 1.7834
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.3480 - loss: 2.1380 - val_accuracy: 0.4590 - val_loss: 1.7599
Epoch 21/50
530/530 2s 3ms/step - accuracy: 0.3446 - loss: 2.1256 - val_accuracy: 0.4370 - val_loss: 1.7977
Epoch 22/50
530/530 2s 4ms/step - accuracy: 0.3579 - loss: 2.1003 - val_accuracy: 0.4520 - val_loss: 1.7803
Epoch 23/50
530/530 3s 5ms/step - accuracy: 0.3592 - loss: 2.1146 - val_accuracy: 0.4770 - val_loss: 1.7356
Epoch 24/50
530/530 2s 3ms/step - accuracy: 0.3570 - loss: 2.1059 - val_accuracy: 0.4820 - val_loss: 1.7442
Epoch 25/50
530/530 2s 3ms/step - accuracy: 0.3636 - loss: 2.1112 - val_accuracy: 0.4610 - val_loss: 1.7814
Epoch 26/50
530/530 2s 3ms/step - accuracy: 0.3559 - loss: 2.1171 - val_accuracy: 0.4660 - val_loss: 1.7557
Epoch 27/50
530/530 3s 3ms/step - accuracy: 0.3478 - loss: 2.1263 - val_accuracy: 0.4550 - val_loss: 1.7504

```
Epoch 28/50
530/530 3s 4ms/step - accuracy: 0.3608 - loss: 2.1071 - val_accuracy: 0.4520 - val_loss: 1.7841
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.3485 - loss: 2.1080 - val_accuracy: 0.4830 - val_loss: 1.7268
Epoch 30/50
530/530 4s 3ms/step - accuracy: 0.3493 - loss: 2.1112 - val_accuracy: 0.4420 - val_loss: 1.7674
Epoch 31/50
530/530 3s 3ms/step - accuracy: 0.3656 - loss: 2.1046 - val_accuracy: 0.4710 - val_loss: 1.7636
Epoch 32/50
530/530 3s 3ms/step - accuracy: 0.3606 - loss: 2.0962 - val_accuracy: 0.4680 - val_loss: 1.7659
Epoch 33/50
530/530 2s 4ms/step - accuracy: 0.3605 - loss: 2.1120 - val_accuracy: 0.4820 - val_loss: 1.7253
Epoch 34/50
530/530 3s 5ms/step - accuracy: 0.3604 - loss: 2.1067 - val_accuracy: 0.4900 - val_loss: 1.7554
Epoch 35/50
530/530 2s 4ms/step - accuracy: 0.3588 - loss: 2.0893 - val_accuracy: 0.4870 - val_loss: 1.7450
Epoch 36/50
530/530 2s 3ms/step - accuracy: 0.3563 - loss: 2.1023 - val_accuracy: 0.4670 - val_loss: 1.7990
Epoch 37/50
530/530 2s 3ms/step - accuracy: 0.3639 - loss: 2.0981 - val_accuracy: 0.4470 - val_loss: 1.7917
Epoch 38/50
530/530 2s 3ms/step - accuracy: 0.3616 - loss: 2.1021 - val_accuracy: 0.4690 - val_loss: 1.7881
Epoch 39/50
530/530 2s 4ms/step - accuracy: 0.3652 - loss: 2.1046 - val_accuracy: 0.4810 - val_loss: 1.7384
Epoch 40/50
530/530 3s 5ms/step - accuracy: 0.3634 - loss: 2.0833 - val_accuracy: 0.4340 - val_loss: 1.8657
Epoch 41/50
530/530 2s 4ms/step - accuracy: 0.3579 - loss: 2.1085 - val_accuracy: 0.4760 - val_loss: 1.7468
Epoch 42/50
530/530 2s 3ms/step - accuracy: 0.3647 - loss: 2.1023 - val_accuracy: 0.4390 - val_loss: 1.7921
Epoch 43/50
530/530 2s 3ms/step - accuracy: 0.3632 - loss: 2.0933 - val_accuracy: 0.4920 - val_loss: 1.7339
Epoch 44/50
530/530 2s 3ms/step - accuracy: 0.3649 - loss: 2.1019 - val_accuracy: 0.4580 - val_loss: 1.7405
Epoch 45/50
530/530 3s 4ms/step - accuracy: 0.3657 - loss: 2.0897 - val_accuracy: 0.4670 - val_loss: 1.7347
Epoch 46/50
530/530 3s 5ms/step - accuracy: 0.3636 - loss: 2.0902 - val_accuracy: 0.4620 - val_loss: 1.7698
Epoch 47/50
530/530 2s 4ms/step - accuracy: 0.3605 - loss: 2.0896 - val_accuracy: 0.4790 - val_loss: 1.7375
Epoch 48/50
530/530 2s 3ms/step - accuracy: 0.3707 - loss: 2.1024 - val_accuracy: 0.4830 - val_loss: 1.7532
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.3669 - loss: 2.0913 - val_accuracy: 0.4960 - val_loss: 1.7371
Epoch 50/50
530/530 2s 3ms/step - accuracy: 0.3583 - loss: 2.1213 - val_accuracy: 0.4830 - val_loss: 1.7561
Accuracy: 0.5035
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_21"

Layer (type)	Output Shape	Param #
dense_102 (Dense)	(None, 32)	352
batch_normalization_81 (BatchNormalization)	(None, 32)	128
dropout_81 (Dropout)	(None, 32)	0
dense_103 (Dense)	(None, 64)	2,112
batch_normalization_82 (BatchNormalization)	(None, 64)	256
dropout_82 (Dropout)	(None, 64)	0
dense_104 (Dense)	(None, 32)	2,080
batch_normalization_83 (BatchNormalization)	(None, 32)	128
dropout_83 (Dropout)	(None, 32)	0
dense_105 (Dense)	(None, 16)	528
batch_normalization_84 (BatchNormalization)	(None, 16)	64
dropout_84 (Dropout)	(None, 16)	0
dense_106 (Dense)	(None, 32)	544
batch_normalization_85 (BatchNormalization)	(None, 32)	128
dropout_85 (Dropout)	(None, 32)	0
dense_107 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 8s 5ms/step - accuracy: 0.3094 - loss: 2.4743 - val_accuracy: 0.5000 - val_loss: 1.7378
Epoch 2/50
265/265 1s 4ms/step - accuracy: 0.4396 - loss: 1.8542 - val_accuracy: 0.5090 - val_loss: 1.6173
Epoch 3/50
265/265 1s 4ms/step - accuracy: 0.4577 - loss: 1.7918 - val_accuracy: 0.4980 - val_loss: 1.6341
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.4643 - loss: 1.7528 - val_accuracy: 0.5290 - val_loss: 1.5102
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.4749 - loss: 1.7245 - val_accuracy: 0.5100 - val_loss: 1.5633
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.4735 - loss: 1.7341 - val_accuracy: 0.5320 - val_loss: 1.4940
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.4810 - loss: 1.7010 - val_accuracy: 0.5360 - val_loss: 1.5221
Epoch 8/50
265/265 1s 4ms/step - accuracy: 0.4818 - loss: 1.7065 - val_accuracy: 0.5270 - val_loss: 1.5406
Epoch 9/50
265/265 2s 5ms/step - accuracy: 0.4841 - loss: 1.6945 - val_accuracy: 0.5640 - val_loss: 1.4697
Epoch 10/50
265/265 1s 5ms/step - accuracy: 0.4874 - loss: 1.6935 - val_accuracy: 0.5380 - val_loss: 1.4830
Epoch 11/50
265/265 2s 4ms/step - accuracy: 0.4996 - loss: 1.6612 - val_accuracy: 0.5490 - val_loss: 1.4892
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.5002 - loss: 1.6584 - val_accuracy: 0.5140 - val_loss: 1.5760
Epoch 13/50
265/265 1s 4ms/step - accuracy: 0.4869 - loss: 1.6813 - val_accuracy: 0.5560 - val_loss: 1.4445
Epoch 14/50
265/265 1s 4ms/step - accuracy: 0.4954 - loss: 1.6587 - val_accuracy: 0.5520 - val_loss: 1.4527
Epoch 15/50
265/265 1s 4ms/step - accuracy: 0.5035 - loss: 1.6412 - val_accuracy: 0.5430 - val_loss: 1.5250
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.4967 - loss: 1.6532 - val_accuracy: 0.5550 - val_loss: 1.4629
Epoch 17/50
265/265 1s 4ms/step - accuracy: 0.4955 - loss: 1.6573 - val_accuracy: 0.5530 - val_loss: 1.4624
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.5143 - loss: 1.6276 - val_accuracy: 0.5410 - val_loss: 1.4539
Epoch 19/50
265/265 2s 5ms/step - accuracy: 0.5008 - loss: 1.6429 - val_accuracy: 0.5500 - val_loss: 1.4509
Epoch 20/50
265/265 2s 6ms/step - accuracy: 0.5102 - loss: 1.6150 - val_accuracy: 0.5410 - val_loss: 1.5098
Epoch 21/50
265/265 2s 4ms/step - accuracy: 0.5019 - loss: 1.6522 - val_accuracy: 0.5550 - val_loss: 1.5013
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.5059 - loss: 1.6241 - val_accuracy: 0.5400 - val_loss: 1.4955
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.5052 - loss: 1.6379 - val_accuracy: 0.5560 - val_loss: 1.4697
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.5123 - loss: 1.6220 - val_accuracy: 0.5690 - val_loss: 1.4291
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.5035 - loss: 1.6254 - val_accuracy: 0.5770 - val_loss: 1.4204
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.5039 - loss: 1.6255 - val_accuracy: 0.5420 - val_loss: 1.4771
Epoch 27/50
265/265 1s 4ms/step - accuracy: 0.5094 - loss: 1.6374 - val_accuracy: 0.5610 - val_loss: 1.4178

```
Epoch 28/50
265/265 1s 4ms/step - accuracy: 0.5082 - loss: 1.6341 - val_accuracy: 0.5460 - val_loss: 1.4675
Epoch 29/50
265/265 1s 4ms/step - accuracy: 0.5008 - loss: 1.6406 - val_accuracy: 0.5700 - val_loss: 1.4429
Epoch 30/50
265/265 2s 5ms/step - accuracy: 0.5141 - loss: 1.6196 - val_accuracy: 0.5580 - val_loss: 1.4600
Epoch 31/50
265/265 1s 5ms/step - accuracy: 0.5074 - loss: 1.6266 - val_accuracy: 0.5640 - val_loss: 1.4354
Epoch 32/50
265/265 2s 4ms/step - accuracy: 0.5049 - loss: 1.6412 - val_accuracy: 0.5720 - val_loss: 1.4253
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.5218 - loss: 1.6034 - val_accuracy: 0.5580 - val_loss: 1.4428
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.5162 - loss: 1.6180 - val_accuracy: 0.5750 - val_loss: 1.3943
Epoch 35/50
265/265 1s 4ms/step - accuracy: 0.5145 - loss: 1.6018 - val_accuracy: 0.5500 - val_loss: 1.4594
Epoch 36/50
265/265 1s 4ms/step - accuracy: 0.5137 - loss: 1.6102 - val_accuracy: 0.5920 - val_loss: 1.4110
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.5201 - loss: 1.5989 - val_accuracy: 0.5660 - val_loss: 1.3982
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.5185 - loss: 1.6110 - val_accuracy: 0.5680 - val_loss: 1.4342
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.5234 - loss: 1.5905 - val_accuracy: 0.5930 - val_loss: 1.3864
Epoch 40/50
265/265 2s 5ms/step - accuracy: 0.5101 - loss: 1.6073 - val_accuracy: 0.5800 - val_loss: 1.3889
Epoch 41/50
265/265 3s 5ms/step - accuracy: 0.5177 - loss: 1.5915 - val_accuracy: 0.5860 - val_loss: 1.4431
Epoch 42/50
265/265 1s 4ms/step - accuracy: 0.5104 - loss: 1.6163 - val_accuracy: 0.5470 - val_loss: 1.5467
Epoch 43/50
265/265 1s 4ms/step - accuracy: 0.5083 - loss: 1.6090 - val_accuracy: 0.5660 - val_loss: 1.4332
Epoch 44/50
265/265 1s 4ms/step - accuracy: 0.5216 - loss: 1.6128 - val_accuracy: 0.5720 - val_loss: 1.4201
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.5152 - loss: 1.6189 - val_accuracy: 0.5560 - val_loss: 1.4385
Epoch 46/50
265/265 1s 4ms/step - accuracy: 0.5265 - loss: 1.5868 - val_accuracy: 0.5920 - val_loss: 1.3979
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.5204 - loss: 1.5963 - val_accuracy: 0.5670 - val_loss: 1.4480
Epoch 48/50
265/265 1s 4ms/step - accuracy: 0.5170 - loss: 1.6157 - val_accuracy: 0.5690 - val_loss: 1.4257
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.5162 - loss: 1.6036 - val_accuracy: 0.5520 - val_loss: 1.4598
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.5158 - loss: 1.6065 - val_accuracy: 0.5830 - val_loss: 1.3977
Accuracy: 0.5790
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_22"

Layer (type)	Output Shape	Param #
dense_108 (Dense)	(None, 32)	352
batch_normalization_86 (BatchNormalization)	(None, 32)	128
dropout_86 (Dropout)	(None, 32)	0
dense_109 (Dense)	(None, 64)	2,112
batch_normalization_87 (BatchNormalization)	(None, 64)	256
dropout_87 (Dropout)	(None, 64)	0
dense_110 (Dense)	(None, 32)	2,080
batch_normalization_88 (BatchNormalization)	(None, 32)	128
dropout_88 (Dropout)	(None, 32)	0
dense_111 (Dense)	(None, 16)	528
batch_normalization_89 (BatchNormalization)	(None, 16)	64
dropout_89 (Dropout)	(None, 16)	0
dense_112 (Dense)	(None, 32)	544
batch_normalization_90 (BatchNormalization)	(None, 32)	128
dropout_90 (Dropout)	(None, 32)	0
dense_113 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 6s 5ms/step - accuracy: 0.2456 - loss: 2.6776 - val_accuracy: 0.4410 - val_loss: 1.8231
Epoch 2/50
265/265 2s 4ms/step - accuracy: 0.3797 - loss: 2.0396 - val_accuracy: 0.4590 - val_loss: 1.7551
Epoch 3/50
265/265 1s 4ms/step - accuracy: 0.3862 - loss: 1.9852 - val_accuracy: 0.4970 - val_loss: 1.6644
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.4097 - loss: 1.9332 - val_accuracy: 0.4710 - val_loss: 1.7036
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.4095 - loss: 1.9258 - val_accuracy: 0.4910 - val_loss: 1.6522
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.4185 - loss: 1.9071 - val_accuracy: 0.5010 - val_loss: 1.6370
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.4114 - loss: 1.9051 - val_accuracy: 0.4850 - val_loss: 1.6461
Epoch 8/50
265/265 1s 5ms/step - accuracy: 0.4164 - loss: 1.8934 - val_accuracy: 0.5010 - val_loss: 1.6349
Epoch 9/50
265/265 2s 6ms/step - accuracy: 0.4273 - loss: 1.8991 - val_accuracy: 0.4960 - val_loss: 1.6248
Epoch 10/50
265/265 1s 4ms/step - accuracy: 0.4270 - loss: 1.8827 - val_accuracy: 0.5010 - val_loss: 1.6717
Epoch 11/50
265/265 1s 3ms/step - accuracy: 0.4296 - loss: 1.8664 - val_accuracy: 0.5070 - val_loss: 1.5899
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.4306 - loss: 1.8665 - val_accuracy: 0.4910 - val_loss: 1.6642
Epoch 13/50
265/265 1s 4ms/step - accuracy: 0.4307 - loss: 1.8742 - val_accuracy: 0.5030 - val_loss: 1.5830
Epoch 14/50
265/265 1s 4ms/step - accuracy: 0.4303 - loss: 1.8775 - val_accuracy: 0.5070 - val_loss: 1.6152
Epoch 15/50
265/265 1s 4ms/step - accuracy: 0.4255 - loss: 1.8762 - val_accuracy: 0.5240 - val_loss: 1.5761
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.4381 - loss: 1.8669 - val_accuracy: 0.4890 - val_loss: 1.6751
Epoch 17/50
265/265 1s 4ms/step - accuracy: 0.4435 - loss: 1.8472 - val_accuracy: 0.5390 - val_loss: 1.5551
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.4390 - loss: 1.8470 - val_accuracy: 0.5120 - val_loss: 1.5998
Epoch 19/50
265/265 1s 5ms/step - accuracy: 0.4431 - loss: 1.8456 - val_accuracy: 0.5110 - val_loss: 1.6193
Epoch 20/50
265/265 1s 5ms/step - accuracy: 0.4373 - loss: 1.8623 - val_accuracy: 0.5210 - val_loss: 1.5818
Epoch 21/50
265/265 2s 4ms/step - accuracy: 0.4371 - loss: 1.8422 - val_accuracy: 0.4910 - val_loss: 1.6064
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.4503 - loss: 1.8286 - val_accuracy: 0.5320 - val_loss: 1.5426
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.4455 - loss: 1.8385 - val_accuracy: 0.5340 - val_loss: 1.5577
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.4490 - loss: 1.8267 - val_accuracy: 0.5120 - val_loss: 1.5889
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.4551 - loss: 1.8282 - val_accuracy: 0.5420 - val_loss: 1.5386
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.4466 - loss: 1.8230 - val_accuracy: 0.5010 - val_loss: 1.6170
Epoch 27/50
265/265 1s 4ms/step - accuracy: 0.4439 - loss: 1.8393 - val_accuracy: 0.5340 - val_loss: 1.5345

```
Epoch 28/50
265/265 1s 4ms/step - accuracy: 0.4491 - loss: 1.8280 - val_accuracy: 0.5340 - val_loss: 1.5748
Epoch 29/50
265/265 1s 4ms/step - accuracy: 0.4526 - loss: 1.8178 - val_accuracy: 0.5270 - val_loss: 1.5717
Epoch 30/50
265/265 1s 5ms/step - accuracy: 0.4563 - loss: 1.8218 - val_accuracy: 0.5370 - val_loss: 1.5444
Epoch 31/50
265/265 2s 6ms/step - accuracy: 0.4532 - loss: 1.8164 - val_accuracy: 0.5100 - val_loss: 1.6085
Epoch 32/50
265/265 1s 5ms/step - accuracy: 0.4514 - loss: 1.8225 - val_accuracy: 0.5310 - val_loss: 1.5720
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.4589 - loss: 1.7861 - val_accuracy: 0.5430 - val_loss: 1.5060
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.4590 - loss: 1.7949 - val_accuracy: 0.5250 - val_loss: 1.5369
Epoch 35/50
265/265 1s 4ms/step - accuracy: 0.4539 - loss: 1.8173 - val_accuracy: 0.5220 - val_loss: 1.5607
Epoch 36/50
265/265 1s 4ms/step - accuracy: 0.4434 - loss: 1.8415 - val_accuracy: 0.5410 - val_loss: 1.5387
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.4459 - loss: 1.8406 - val_accuracy: 0.5070 - val_loss: 1.6151
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.4393 - loss: 1.8474 - val_accuracy: 0.5170 - val_loss: 1.5787
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.4445 - loss: 1.8490 - val_accuracy: 0.5100 - val_loss: 1.6026
Epoch 40/50
265/265 1s 4ms/step - accuracy: 0.4477 - loss: 1.8441 - val_accuracy: 0.5320 - val_loss: 1.5620
Epoch 41/50
265/265 2s 5ms/step - accuracy: 0.4529 - loss: 1.8315 - val_accuracy: 0.5110 - val_loss: 1.5788
Epoch 42/50
265/265 2s 5ms/step - accuracy: 0.4598 - loss: 1.8114 - val_accuracy: 0.5460 - val_loss: 1.5305
Epoch 43/50
265/265 1s 4ms/step - accuracy: 0.4548 - loss: 1.8137 - val_accuracy: 0.5150 - val_loss: 1.5552
Epoch 44/50
265/265 1s 4ms/step - accuracy: 0.4548 - loss: 1.8103 - val_accuracy: 0.5330 - val_loss: 1.5462
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.4543 - loss: 1.8270 - val_accuracy: 0.5390 - val_loss: 1.5281
Epoch 46/50
265/265 1s 4ms/step - accuracy: 0.4536 - loss: 1.8038 - val_accuracy: 0.5320 - val_loss: 1.5471
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.4604 - loss: 1.8142 - val_accuracy: 0.5340 - val_loss: 1.5241
Epoch 48/50
265/265 1s 4ms/step - accuracy: 0.4544 - loss: 1.8007 - val_accuracy: 0.5420 - val_loss: 1.5106
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.4496 - loss: 1.8077 - val_accuracy: 0.5120 - val_loss: 1.6086
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.4464 - loss: 1.8107 - val_accuracy: 0.5510 - val_loss: 1.5231
Accuracy: 0.5450
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_23"

Layer (type)	Output Shape	Param #
dense_114 (Dense)	(None, 32)	352
batch_normalization_91 (BatchNormalization)	(None, 32)	128
dropout_91 (Dropout)	(None, 32)	0
dense_115 (Dense)	(None, 64)	2,112
batch_normalization_92 (BatchNormalization)	(None, 64)	256
dropout_92 (Dropout)	(None, 64)	0
dense_116 (Dense)	(None, 32)	2,080
batch_normalization_93 (BatchNormalization)	(None, 32)	128
dropout_93 (Dropout)	(None, 32)	0
dense_117 (Dense)	(None, 16)	528
batch_normalization_94 (BatchNormalization)	(None, 16)	64
dropout_94 (Dropout)	(None, 16)	0
dense_118 (Dense)	(None, 32)	544
batch_normalization_95 (BatchNormalization)	(None, 32)	128
dropout_95 (Dropout)	(None, 32)	0
dense_119 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 6s 5ms/step - accuracy: 0.1923 - loss: 2.8364 - val_accuracy: 0.3300 - val_loss: 2.0708
Epoch 2/50
265/265 1s 4ms/step - accuracy: 0.3158 - loss: 2.1831 - val_accuracy: 0.4280 - val_loss: 1.8199
Epoch 3/50
265/265 1s 4ms/step - accuracy: 0.3247 - loss: 2.1383 - val_accuracy: 0.4090 - val_loss: 1.8908
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.3481 - loss: 2.0785 - val_accuracy: 0.4230 - val_loss: 1.8233
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.3412 - loss: 2.1026 - val_accuracy: 0.4440 - val_loss: 1.7394
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.3468 - loss: 2.0898 - val_accuracy: 0.4490 - val_loss: 1.7702
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.3534 - loss: 2.0660 - val_accuracy: 0.4340 - val_loss: 1.7457
Epoch 8/50
265/265 1s 4ms/step - accuracy: 0.3596 - loss: 2.0447 - val_accuracy: 0.4070 - val_loss: 1.8521
Epoch 9/50
265/265 1s 5ms/step - accuracy: 0.3660 - loss: 2.0439 - val_accuracy: 0.4280 - val_loss: 1.7859
Epoch 10/50
265/265 2s 4ms/step - accuracy: 0.3607 - loss: 2.0435 - val_accuracy: 0.4970 - val_loss: 1.7171
Epoch 11/50
265/265 1s 3ms/step - accuracy: 0.3711 - loss: 2.0511 - val_accuracy: 0.4680 - val_loss: 1.7345
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.3721 - loss: 2.0146 - val_accuracy: 0.4890 - val_loss: 1.7290
Epoch 13/50
265/265 1s 3ms/step - accuracy: 0.3719 - loss: 2.0227 - val_accuracy: 0.4680 - val_loss: 1.7273
Epoch 14/50
265/265 1s 4ms/step - accuracy: 0.3704 - loss: 2.0365 - val_accuracy: 0.4610 - val_loss: 1.7155
Epoch 15/50
265/265 1s 4ms/step - accuracy: 0.3737 - loss: 2.0228 - val_accuracy: 0.4450 - val_loss: 1.6990
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.3743 - loss: 2.0182 - val_accuracy: 0.4710 - val_loss: 1.7001
Epoch 17/50
265/265 1s 4ms/step - accuracy: 0.3763 - loss: 2.0064 - val_accuracy: 0.4880 - val_loss: 1.6834
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.3911 - loss: 1.9914 - val_accuracy: 0.4760 - val_loss: 1.7011
Epoch 19/50
265/265 1s 5ms/step - accuracy: 0.3871 - loss: 2.0133 - val_accuracy: 0.4760 - val_loss: 1.7117
Epoch 20/50
265/265 1s 5ms/step - accuracy: 0.3813 - loss: 2.0089 - val_accuracy: 0.5100 - val_loss: 1.6713
Epoch 21/50
265/265 2s 3ms/step - accuracy: 0.3811 - loss: 2.0156 - val_accuracy: 0.4990 - val_loss: 1.6443
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.3889 - loss: 1.9863 - val_accuracy: 0.4930 - val_loss: 1.6732
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.3861 - loss: 2.0129 - val_accuracy: 0.4900 - val_loss: 1.6847
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.3870 - loss: 2.0152 - val_accuracy: 0.5020 - val_loss: 1.6579
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.3859 - loss: 1.9961 - val_accuracy: 0.5000 - val_loss: 1.6603
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.3760 - loss: 2.0070 - val_accuracy: 0.4950 - val_loss: 1.6331
Epoch 27/50
265/265 1s 4ms/step - accuracy: 0.3929 - loss: 1.9767 - val_accuracy: 0.4940 - val_loss: 1.6625

```
Epoch 28/50
265/265 1s 4ms/step - accuracy: 0.3936 - loss: 2.0074 - val_accuracy: 0.5030 - val_loss: 1.6837
Epoch 29/50
265/265 2s 5ms/step - accuracy: 0.3938 - loss: 2.0106 - val_accuracy: 0.4720 - val_loss: 1.7028
Epoch 30/50
265/265 1s 5ms/step - accuracy: 0.3880 - loss: 2.0039 - val_accuracy: 0.4830 - val_loss: 1.6686
Epoch 31/50
265/265 2s 3ms/step - accuracy: 0.3913 - loss: 1.9759 - val_accuracy: 0.4930 - val_loss: 1.6712
Epoch 32/50
265/265 1s 4ms/step - accuracy: 0.3878 - loss: 1.9857 - val_accuracy: 0.4860 - val_loss: 1.6777
Epoch 33/50
265/265 1s 3ms/step - accuracy: 0.3942 - loss: 1.9759 - val_accuracy: 0.5020 - val_loss: 1.6348
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.3893 - loss: 1.9848 - val_accuracy: 0.4770 - val_loss: 1.6690
Epoch 35/50
265/265 1s 4ms/step - accuracy: 0.3896 - loss: 1.9950 - val_accuracy: 0.4510 - val_loss: 1.7804
Epoch 36/50
265/265 1s 4ms/step - accuracy: 0.3905 - loss: 1.9812 - val_accuracy: 0.4960 - val_loss: 1.6694
Epoch 37/50
265/265 1s 3ms/step - accuracy: 0.3986 - loss: 1.9663 - val_accuracy: 0.4900 - val_loss: 1.7026
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.3887 - loss: 1.9915 - val_accuracy: 0.5100 - val_loss: 1.6312
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.3891 - loss: 1.9826 - val_accuracy: 0.4920 - val_loss: 1.6858
Epoch 40/50
265/265 1s 5ms/step - accuracy: 0.3935 - loss: 1.9930 - val_accuracy: 0.4930 - val_loss: 1.6730
Epoch 41/50
265/265 2s 4ms/step - accuracy: 0.3932 - loss: 1.9857 - val_accuracy: 0.5310 - val_loss: 1.6105
Epoch 42/50
265/265 1s 4ms/step - accuracy: 0.3986 - loss: 1.9836 - val_accuracy: 0.4940 - val_loss: 1.6595
Epoch 43/50
265/265 1s 3ms/step - accuracy: 0.3927 - loss: 1.9852 - val_accuracy: 0.5100 - val_loss: 1.6198
Epoch 44/50
265/265 1s 4ms/step - accuracy: 0.4012 - loss: 1.9783 - val_accuracy: 0.4930 - val_loss: 1.6393
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.3957 - loss: 1.9816 - val_accuracy: 0.5190 - val_loss: 1.6342
Epoch 46/50
265/265 1s 4ms/step - accuracy: 0.3955 - loss: 1.9681 - val_accuracy: 0.4720 - val_loss: 1.7627
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.3932 - loss: 1.9797 - val_accuracy: 0.5090 - val_loss: 1.6208
Epoch 48/50
265/265 1s 4ms/step - accuracy: 0.4008 - loss: 1.9839 - val_accuracy: 0.4810 - val_loss: 1.6820
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.4054 - loss: 1.9799 - val_accuracy: 0.4930 - val_loss: 1.6646
Epoch 50/50
265/265 2s 6ms/step - accuracy: 0.3898 - loss: 1.9920 - val_accuracy: 0.4750 - val_loss: 1.6658
Accuracy: 0.4765
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_24"

Layer (type)	Output Shape	Param #
dense_120 (Dense)	(None, 32)	352
batch_normalization_96 (BatchNormalization)	(None, 32)	128
dropout_96 (Dropout)	(None, 32)	0
dense_121 (Dense)	(None, 64)	2,112
batch_normalization_97 (BatchNormalization)	(None, 64)	256
dropout_97 (Dropout)	(None, 64)	0
dense_122 (Dense)	(None, 32)	2,080
batch_normalization_98 (BatchNormalization)	(None, 32)	128
dropout_98 (Dropout)	(None, 32)	0
dense_123 (Dense)	(None, 16)	528
batch_normalization_99 (BatchNormalization)	(None, 16)	64
dropout_99 (Dropout)	(None, 16)	0
dense_124 (Dense)	(None, 32)	544
batch_normalization_100 (BatchNormalization)	(None, 32)	128
dropout_100 (Dropout)	(None, 32)	0
dense_125 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 6s 4ms/step - accuracy: 0.2030 - loss: 2.9183 - val_accuracy: 0.2700 - val_loss: 2.6851
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.2518 - loss: 2.6439 - val_accuracy: 0.2480 - val_loss: 3.0796
Epoch 3/50
530/530 3s 3ms/step - accuracy: 0.2563 - loss: 2.6213 - val_accuracy: 0.3070 - val_loss: 2.4564
Epoch 4/50
530/530 3s 5ms/step - accuracy: 0.2611 - loss: 2.6251 - val_accuracy: 0.3110 - val_loss: 2.5836
Epoch 5/50
530/530 4s 3ms/step - accuracy: 0.2590 - loss: 2.6363 - val_accuracy: 0.3100 - val_loss: 2.3537
Epoch 6/50
530/530 2s 3ms/step - accuracy: 0.2703 - loss: 2.5881 - val_accuracy: 0.3030 - val_loss: 2.4828
Epoch 7/50
530/530 3s 3ms/step - accuracy: 0.2747 - loss: 2.5845 - val_accuracy: 0.2790 - val_loss: 2.6345
Epoch 8/50
530/530 2s 3ms/step - accuracy: 0.2691 - loss: 2.5899 - val_accuracy: 0.3180 - val_loss: 2.3821
Epoch 9/50
530/530 3s 5ms/step - accuracy: 0.2802 - loss: 2.5647 - val_accuracy: 0.2030 - val_loss: 2.7130
Epoch 10/50
530/530 2s 5ms/step - accuracy: 0.2697 - loss: 2.6048 - val_accuracy: 0.3460 - val_loss: 2.3695
Epoch 11/50
530/530 2s 3ms/step - accuracy: 0.2744 - loss: 2.5940 - val_accuracy: 0.3850 - val_loss: 2.2354
Epoch 12/50
530/530 2s 3ms/step - accuracy: 0.2838 - loss: 2.5760 - val_accuracy: 0.3110 - val_loss: 2.4397
Epoch 13/50
530/530 3s 3ms/step - accuracy: 0.2848 - loss: 2.5543 - val_accuracy: 0.3610 - val_loss: 2.3982
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.2850 - loss: 2.5456 - val_accuracy: 0.3690 - val_loss: 2.3089
Epoch 15/50
530/530 2s 4ms/step - accuracy: 0.2827 - loss: 2.5529 - val_accuracy: 0.3610 - val_loss: 2.2491
Epoch 16/50
530/530 3s 5ms/step - accuracy: 0.2818 - loss: 2.5812 - val_accuracy: 0.3510 - val_loss: 2.3922
Epoch 17/50
530/530 2s 4ms/step - accuracy: 0.2879 - loss: 2.5897 - val_accuracy: 0.2990 - val_loss: 2.4215
Epoch 18/50
530/530 2s 3ms/step - accuracy: 0.2916 - loss: 2.5580 - val_accuracy: 0.3440 - val_loss: 2.3545
Epoch 19/50
530/530 3s 3ms/step - accuracy: 0.2962 - loss: 2.5586 - val_accuracy: 0.3390 - val_loss: 2.3270
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.2891 - loss: 2.5636 - val_accuracy: 0.3410 - val_loss: 2.4011
Epoch 21/50
530/530 2s 4ms/step - accuracy: 0.2879 - loss: 2.6038 - val_accuracy: 0.3140 - val_loss: 2.4954
Epoch 22/50
530/530 2s 4ms/step - accuracy: 0.2889 - loss: 2.5681 - val_accuracy: 0.3540 - val_loss: 2.3866
Epoch 23/50
530/530 3s 5ms/step - accuracy: 0.2896 - loss: 2.5476 - val_accuracy: 0.2460 - val_loss: 2.7195
Epoch 24/50
530/530 2s 3ms/step - accuracy: 0.3045 - loss: 2.5399 - val_accuracy: 0.3410 - val_loss: 2.3308
Epoch 25/50
530/530 2s 3ms/step - accuracy: 0.3126 - loss: 2.5219 - val_accuracy: 0.3160 - val_loss: 2.3920
Epoch 26/50
530/530 3s 3ms/step - accuracy: 0.2962 - loss: 2.5535 - val_accuracy: 0.3420 - val_loss: 2.4223
Epoch 27/50
530/530 2s 3ms/step - accuracy: 0.3011 - loss: 2.5456 - val_accuracy: 0.3450 - val_loss: 2.4846

```
Epoch 28/50
530/530 2s 3ms/step - accuracy: 0.3001 - loss: 2.5570 - val_accuracy: 0.3510 - val_loss: 2.3298
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.3042 - loss: 2.5501 - val_accuracy: 0.3810 - val_loss: 2.2907
Epoch 30/50
530/530 3s 5ms/step - accuracy: 0.3026 - loss: 2.5251 - val_accuracy: 0.3230 - val_loss: 2.4808
Epoch 31/50
530/530 4s 3ms/step - accuracy: 0.3096 - loss: 2.5277 - val_accuracy: 0.3280 - val_loss: 2.4834
Epoch 32/50
530/530 3s 3ms/step - accuracy: 0.2991 - loss: 2.5820 - val_accuracy: 0.3790 - val_loss: 2.2836
Epoch 33/50
530/530 3s 3ms/step - accuracy: 0.3160 - loss: 2.5080 - val_accuracy: 0.3760 - val_loss: 2.2557
Epoch 34/50
530/530 3s 5ms/step - accuracy: 0.3088 - loss: 2.5429 - val_accuracy: 0.3560 - val_loss: 2.2900
Epoch 35/50
530/530 4s 3ms/step - accuracy: 0.3083 - loss: 2.5128 - val_accuracy: 0.3200 - val_loss: 2.4514
Epoch 36/50
530/530 2s 3ms/step - accuracy: 0.3047 - loss: 2.5322 - val_accuracy: 0.3600 - val_loss: 2.3341
Epoch 37/50
530/530 2s 3ms/step - accuracy: 0.3087 - loss: 2.5249 - val_accuracy: 0.3220 - val_loss: 2.3771
Epoch 38/50
530/530 3s 3ms/step - accuracy: 0.3029 - loss: 2.5644 - val_accuracy: 0.4150 - val_loss: 2.1930
Epoch 39/50
530/530 3s 5ms/step - accuracy: 0.3088 - loss: 2.5343 - val_accuracy: 0.3740 - val_loss: 2.3091
Epoch 40/50
530/530 4s 3ms/step - accuracy: 0.3126 - loss: 2.5013 - val_accuracy: 0.3430 - val_loss: 2.3204
Epoch 41/50
530/530 3s 3ms/step - accuracy: 0.3020 - loss: 2.5624 - val_accuracy: 0.3600 - val_loss: 2.4088
Epoch 42/50
530/530 2s 3ms/step - accuracy: 0.2992 - loss: 2.5575 - val_accuracy: 0.3480 - val_loss: 2.3813
Epoch 43/50
530/530 2s 4ms/step - accuracy: 0.3112 - loss: 2.5178 - val_accuracy: 0.3400 - val_loss: 2.2587
Epoch 44/50
530/530 3s 5ms/step - accuracy: 0.3037 - loss: 2.4964 - val_accuracy: 0.2030 - val_loss: 4.9167
Epoch 45/50
530/530 4s 3ms/step - accuracy: 0.2536 - loss: 3.0536 - val_accuracy: 0.3480 - val_loss: 2.3119
Epoch 46/50
530/530 2s 3ms/step - accuracy: 0.2799 - loss: 2.5655 - val_accuracy: 0.3360 - val_loss: 2.3020
Epoch 47/50
530/530 2s 3ms/step - accuracy: 0.2914 - loss: 2.5600 - val_accuracy: 0.3120 - val_loss: 2.3728
Epoch 48/50
530/530 3s 4ms/step - accuracy: 0.2915 - loss: 2.5668 - val_accuracy: 0.3480 - val_loss: 2.3326
Epoch 49/50
530/530 3s 5ms/step - accuracy: 0.2882 - loss: 2.5421 - val_accuracy: 0.3400 - val_loss: 2.3009
Epoch 50/50
530/530 2s 4ms/step - accuracy: 0.3034 - loss: 2.5152 - val_accuracy: 0.3590 - val_loss: 2.3918
Accuracy: 0.3585
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_25"

Layer (type)	Output Shape	Param #
dense_126 (Dense)	(None, 32)	352
batch_normalization_101 (BatchNormalization)	(None, 32)	128
dropout_101 (Dropout)	(None, 32)	0
dense_127 (Dense)	(None, 64)	2,112
batch_normalization_102 (BatchNormalization)	(None, 64)	256
dropout_102 (Dropout)	(None, 64)	0
dense_128 (Dense)	(None, 32)	2,080
batch_normalization_103 (BatchNormalization)	(None, 32)	128
dropout_103 (Dropout)	(None, 32)	0
dense_129 (Dense)	(None, 16)	528
batch_normalization_104 (BatchNormalization)	(None, 16)	64
dropout_104 (Dropout)	(None, 16)	0
dense_130 (Dense)	(None, 32)	544
batch_normalization_105 (BatchNormalization)	(None, 32)	128
dropout_105 (Dropout)	(None, 32)	0
dense_131 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 6s 4ms/step - accuracy: 0.1570 - loss: 3.0537 - val_accuracy: 0.2330 - val_loss: 3.0713
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.1833 - loss: 2.8590 - val_accuracy: 0.2180 - val_loss: 2.6432
Epoch 3/50
530/530 4s 6ms/step - accuracy: 0.1960 - loss: 2.8106 - val_accuracy: 0.2550 - val_loss: 2.5600
Epoch 4/50
530/530 4s 3ms/step - accuracy: 0.2064 - loss: 2.7980 - val_accuracy: 0.2380 - val_loss: 2.6965
Epoch 5/50
530/530 3s 3ms/step - accuracy: 0.2119 - loss: 2.7844 - val_accuracy: 0.2610 - val_loss: 2.6448
Epoch 6/50
530/530 2s 3ms/step - accuracy: 0.2156 - loss: 2.7946 - val_accuracy: 0.1800 - val_loss: 2.8366
Epoch 7/50
530/530 2s 3ms/step - accuracy: 0.2113 - loss: 2.7849 - val_accuracy: 0.2600 - val_loss: 2.5250
Epoch 8/50
530/530 3s 5ms/step - accuracy: 0.2223 - loss: 2.7857 - val_accuracy: 0.2760 - val_loss: 2.6236
Epoch 9/50
530/530 4s 3ms/step - accuracy: 0.2143 - loss: 2.7751 - val_accuracy: 0.2500 - val_loss: 2.5852
Epoch 10/50
530/530 3s 3ms/step - accuracy: 0.2153 - loss: 2.7846 - val_accuracy: 0.2410 - val_loss: 2.7535
Epoch 11/50
530/530 2s 3ms/step - accuracy: 0.2164 - loss: 2.8093 - val_accuracy: 0.2800 - val_loss: 2.5779
Epoch 12/50
530/530 3s 4ms/step - accuracy: 0.2240 - loss: 2.7748 - val_accuracy: 0.2450 - val_loss: 2.5965
Epoch 13/50
530/530 3s 5ms/step - accuracy: 0.2249 - loss: 2.7762 - val_accuracy: 0.1660 - val_loss: 3.1267
Epoch 14/50
530/530 4s 3ms/step - accuracy: 0.2168 - loss: 2.7983 - val_accuracy: 0.2950 - val_loss: 2.4817
Epoch 15/50
530/530 3s 3ms/step - accuracy: 0.2282 - loss: 2.7737 - val_accuracy: 0.3080 - val_loss: 2.4264
Epoch 16/50
530/530 2s 3ms/step - accuracy: 0.2229 - loss: 2.7824 - val_accuracy: 0.3020 - val_loss: 2.5755
Epoch 17/50
530/530 3s 4ms/step - accuracy: 0.2354 - loss: 2.7638 - val_accuracy: 0.2910 - val_loss: 2.5163
Epoch 18/50
530/530 3s 5ms/step - accuracy: 0.2297 - loss: 2.7655 - val_accuracy: 0.2980 - val_loss: 2.5310
Epoch 19/50
530/530 2s 4ms/step - accuracy: 0.2275 - loss: 2.7679 - val_accuracy: 0.2760 - val_loss: 2.5928
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.2439 - loss: 2.8091 - val_accuracy: 0.2680 - val_loss: 2.6327
Epoch 21/50
530/530 2s 3ms/step - accuracy: 0.2259 - loss: 2.7721 - val_accuracy: 0.3300 - val_loss: 2.5752
Epoch 22/50
530/530 3s 3ms/step - accuracy: 0.2286 - loss: 2.7638 - val_accuracy: 0.2610 - val_loss: 2.6692
Epoch 23/50
530/530 3s 4ms/step - accuracy: 0.2370 - loss: 2.7441 - val_accuracy: 0.3000 - val_loss: 2.4661
Epoch 24/50
530/530 3s 5ms/step - accuracy: 0.2358 - loss: 2.7630 - val_accuracy: 0.2460 - val_loss: 2.7314
Epoch 25/50
530/530 2s 4ms/step - accuracy: 0.2322 - loss: 2.7954 - val_accuracy: 0.2090 - val_loss: 3.1587
Epoch 26/50
530/530 2s 3ms/step - accuracy: 0.2424 - loss: 2.7704 - val_accuracy: 0.3180 - val_loss: 2.4919
Epoch 27/50
530/530 3s 3ms/step - accuracy: 0.2466 - loss: 2.7352 - val_accuracy: 0.1870 - val_loss: 3.0536

```
Epoch 28/50
530/530 3s 3ms/step - accuracy: 0.2445 - loss: 2.7693 - val_accuracy: 0.3300 - val_loss: 2.4954
Epoch 29/50
530/530 3s 4ms/step - accuracy: 0.2321 - loss: 2.7620 - val_accuracy: 0.2870 - val_loss: 2.6344
Epoch 30/50
530/530 3s 5ms/step - accuracy: 0.2507 - loss: 2.7263 - val_accuracy: 0.3070 - val_loss: 2.4443
Epoch 31/50
530/530 2s 4ms/step - accuracy: 0.2378 - loss: 2.7606 - val_accuracy: 0.2800 - val_loss: 2.5969
Epoch 32/50
530/530 2s 3ms/step - accuracy: 0.2285 - loss: 2.7744 - val_accuracy: 0.2420 - val_loss: 2.6201
Epoch 33/50
530/530 3s 3ms/step - accuracy: 0.2321 - loss: 2.7621 - val_accuracy: 0.3220 - val_loss: 2.5079
Epoch 34/50
530/530 2s 3ms/step - accuracy: 0.2496 - loss: 2.7433 - val_accuracy: 0.2390 - val_loss: 2.6413
Epoch 35/50
530/530 2s 4ms/step - accuracy: 0.2479 - loss: 2.7607 - val_accuracy: 0.2850 - val_loss: 2.5022
Epoch 36/50
530/530 3s 5ms/step - accuracy: 0.2462 - loss: 2.7460 - val_accuracy: 0.2930 - val_loss: 2.5975
Epoch 37/50
530/530 4s 3ms/step - accuracy: 0.2456 - loss: 2.7661 - val_accuracy: 0.2880 - val_loss: 2.6529
Epoch 38/50
530/530 3s 3ms/step - accuracy: 0.2466 - loss: 2.7541 - val_accuracy: 0.3560 - val_loss: 2.3727
Epoch 39/50
530/530 2s 3ms/step - accuracy: 0.2444 - loss: 2.7307 - val_accuracy: 0.3200 - val_loss: 2.3895
Epoch 40/50
530/530 2s 3ms/step - accuracy: 0.2383 - loss: 2.7502 - val_accuracy: 0.3110 - val_loss: 2.3777
Epoch 41/50
530/530 3s 5ms/step - accuracy: 0.2380 - loss: 2.7564 - val_accuracy: 0.3020 - val_loss: 2.5805
Epoch 42/50
530/530 4s 3ms/step - accuracy: 0.2451 - loss: 2.7660 - val_accuracy: 0.2990 - val_loss: 2.6778
Epoch 43/50
530/530 2s 3ms/step - accuracy: 0.2429 - loss: 2.7815 - val_accuracy: 0.2760 - val_loss: 2.5541
Epoch 44/50
530/530 2s 3ms/step - accuracy: 0.2512 - loss: 2.7466 - val_accuracy: 0.3050 - val_loss: 2.7600
Epoch 45/50
530/530 3s 4ms/step - accuracy: 0.2461 - loss: 2.7462 - val_accuracy: 0.3520 - val_loss: 2.5498
Epoch 46/50
530/530 3s 5ms/step - accuracy: 0.2426 - loss: 2.7764 - val_accuracy: 0.3200 - val_loss: 2.4679
Epoch 47/50
530/530 4s 3ms/step - accuracy: 0.2576 - loss: 2.7168 - val_accuracy: 0.2690 - val_loss: 2.5873
Epoch 48/50
530/530 3s 4ms/step - accuracy: 0.2511 - loss: 2.7409 - val_accuracy: 0.2170 - val_loss: 2.6775
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.2482 - loss: 2.7366 - val_accuracy: 0.3000 - val_loss: 2.4586
Epoch 50/50
530/530 3s 5ms/step - accuracy: 0.2504 - loss: 2.7608 - val_accuracy: 0.2800 - val_loss: 2.4422
Accuracy: 0.2930
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_26"

Layer (type)	Output Shape	Param #
dense_132 (Dense)	(None, 32)	352
batch_normalization_106 (BatchNormalization)	(None, 32)	128
dropout_106 (Dropout)	(None, 32)	0
dense_133 (Dense)	(None, 64)	2,112
batch_normalization_107 (BatchNormalization)	(None, 64)	256
dropout_107 (Dropout)	(None, 64)	0
dense_134 (Dense)	(None, 32)	2,080
batch_normalization_108 (BatchNormalization)	(None, 32)	128
dropout_108 (Dropout)	(None, 32)	0
dense_135 (Dense)	(None, 16)	528
batch_normalization_109 (BatchNormalization)	(None, 16)	64
dropout_109 (Dropout)	(None, 16)	0
dense_136 (Dense)	(None, 32)	544
batch_normalization_110 (BatchNormalization)	(None, 32)	128
dropout_110 (Dropout)	(None, 32)	0
dense_137 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
530/530 6s 4ms/step - accuracy: 0.1240 - loss: 3.1884 - val_accuracy: 0.1620 - val_loss: 2.9504
Epoch 2/50
530/530 2s 3ms/step - accuracy: 0.1459 - loss: 2.9796 - val_accuracy: 0.1580 - val_loss: 2.9406
Epoch 3/50
530/530 2s 3ms/step - accuracy: 0.1583 - loss: 2.9421 - val_accuracy: 0.1610 - val_loss: 2.9458
Epoch 4/50
530/530 3s 5ms/step - accuracy: 0.1701 - loss: 2.9474 - val_accuracy: 0.2210 - val_loss: 2.7800
Epoch 5/50
530/530 3s 5ms/step - accuracy: 0.1622 - loss: 2.9435 - val_accuracy: 0.1860 - val_loss: 2.6507
Epoch 6/50
530/530 2s 3ms/step - accuracy: 0.1718 - loss: 2.9005 - val_accuracy: 0.2360 - val_loss: 2.8316
Epoch 7/50
530/530 3s 3ms/step - accuracy: 0.1603 - loss: 2.9688 - val_accuracy: 0.2070 - val_loss: 2.6570
Epoch 8/50
530/530 2s 3ms/step - accuracy: 0.1662 - loss: 2.9218 - val_accuracy: 0.2360 - val_loss: 2.8496
Epoch 9/50
530/530 2s 3ms/step - accuracy: 0.1828 - loss: 2.9161 - val_accuracy: 0.2420 - val_loss: 2.6440
Epoch 10/50
530/530 2s 3ms/step - accuracy: 0.1578 - loss: 2.9430 - val_accuracy: 0.2190 - val_loss: 2.7591
Epoch 11/50
530/530 3s 5ms/step - accuracy: 0.1850 - loss: 2.9127 - val_accuracy: 0.1580 - val_loss: 3.1523
Epoch 12/50
530/530 4s 3ms/step - accuracy: 0.1744 - loss: 2.9414 - val_accuracy: 0.2190 - val_loss: 2.7352
Epoch 13/50
530/530 3s 3ms/step - accuracy: 0.1693 - loss: 2.9321 - val_accuracy: 0.2040 - val_loss: 2.7763
Epoch 14/50
530/530 2s 3ms/step - accuracy: 0.1754 - loss: 2.8961 - val_accuracy: 0.2360 - val_loss: 2.8093
Epoch 15/50
530/530 2s 3ms/step - accuracy: 0.1806 - loss: 2.9046 - val_accuracy: 0.1790 - val_loss: 2.8318
Epoch 16/50
530/530 2s 4ms/step - accuracy: 0.1771 - loss: 2.9016 - val_accuracy: 0.1960 - val_loss: 2.6624
Epoch 17/50
530/530 3s 5ms/step - accuracy: 0.1772 - loss: 2.9259 - val_accuracy: 0.1870 - val_loss: 2.6956
Epoch 18/50
530/530 2s 3ms/step - accuracy: 0.1823 - loss: 2.8728 - val_accuracy: 0.2160 - val_loss: 2.7344
Epoch 19/50
530/530 2s 3ms/step - accuracy: 0.1816 - loss: 2.8930 - val_accuracy: 0.2000 - val_loss: 2.7222
Epoch 20/50
530/530 2s 3ms/step - accuracy: 0.1812 - loss: 2.8901 - val_accuracy: 0.1590 - val_loss: 2.8182
Epoch 21/50
530/530 3s 3ms/step - accuracy: 0.1844 - loss: 2.8854 - val_accuracy: 0.1790 - val_loss: 2.7502
Epoch 22/50
530/530 2s 4ms/step - accuracy: 0.1877 - loss: 2.9186 - val_accuracy: 0.2590 - val_loss: 2.6049
Epoch 23/50
530/530 3s 5ms/step - accuracy: 0.1848 - loss: 2.8884 - val_accuracy: 0.1790 - val_loss: 2.7586
Epoch 24/50
530/530 4s 3ms/step - accuracy: 0.1833 - loss: 2.8865 - val_accuracy: 0.2100 - val_loss: 2.7569
Epoch 25/50
530/530 3s 3ms/step - accuracy: 0.1834 - loss: 2.8866 - val_accuracy: 0.2290 - val_loss: 2.7080
Epoch 26/50
530/530 2s 3ms/step - accuracy: 0.1852 - loss: 2.8902 - val_accuracy: 0.2080 - val_loss: 2.7786
Epoch 27/50
530/530 2s 4ms/step - accuracy: 0.1843 - loss: 2.8926 - val_accuracy: 0.2470 - val_loss: 2.7874

```
Epoch 28/50
530/530 3s 5ms/step - accuracy: 0.1929 - loss: 2.8965 - val_accuracy: 0.2210 - val_loss: 2.6287
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.1814 - loss: 2.9015 - val_accuracy: 0.2410 - val_loss: 2.6714
Epoch 30/50
530/530 4s 3ms/step - accuracy: 0.1876 - loss: 2.8678 - val_accuracy: 0.2500 - val_loss: 2.6608
Epoch 31/50
530/530 2s 3ms/step - accuracy: 0.1834 - loss: 2.8928 - val_accuracy: 0.1730 - val_loss: 2.8121
Epoch 32/50
530/530 2s 4ms/step - accuracy: 0.1851 - loss: 2.8938 - val_accuracy: 0.2500 - val_loss: 2.6643
Epoch 33/50
530/530 3s 4ms/step - accuracy: 0.1925 - loss: 2.8988 - val_accuracy: 0.1850 - val_loss: 2.7344
Epoch 34/50
530/530 3s 5ms/step - accuracy: 0.1865 - loss: 2.8868 - val_accuracy: 0.2290 - val_loss: 2.7681
Epoch 35/50
530/530 3s 5ms/step - accuracy: 0.1856 - loss: 2.9034 - val_accuracy: 0.2780 - val_loss: 2.6095
Epoch 36/50
530/530 4s 4ms/step - accuracy: 0.1946 - loss: 2.8714 - val_accuracy: 0.2340 - val_loss: 2.5943
Epoch 37/50
530/530 3s 4ms/step - accuracy: 0.1907 - loss: 2.8846 - val_accuracy: 0.2360 - val_loss: 2.5711
Epoch 38/50
530/530 2s 4ms/step - accuracy: 0.1879 - loss: 2.8905 - val_accuracy: 0.1870 - val_loss: 2.6698
Epoch 39/50
530/530 3s 5ms/step - accuracy: 0.1836 - loss: 2.9101 - val_accuracy: 0.2740 - val_loss: 2.5841
Epoch 40/50
530/530 2s 4ms/step - accuracy: 0.1908 - loss: 2.8830 - val_accuracy: 0.2220 - val_loss: 2.6095
Epoch 41/50
530/530 2s 3ms/step - accuracy: 0.1866 - loss: 2.8893 - val_accuracy: 0.2490 - val_loss: 2.6282
Epoch 42/50
530/530 3s 4ms/step - accuracy: 0.1925 - loss: 2.8883 - val_accuracy: 0.2030 - val_loss: 2.8606
Epoch 43/50
530/530 2s 4ms/step - accuracy: 0.1802 - loss: 2.9154 - val_accuracy: 0.2290 - val_loss: 2.7916
Epoch 44/50
530/530 3s 4ms/step - accuracy: 0.1913 - loss: 2.8806 - val_accuracy: 0.2230 - val_loss: 2.7096
Epoch 45/50
530/530 3s 5ms/step - accuracy: 0.1879 - loss: 2.8952 - val_accuracy: 0.2370 - val_loss: 2.7714
Epoch 46/50
530/530 2s 4ms/step - accuracy: 0.1840 - loss: 2.8852 - val_accuracy: 0.2120 - val_loss: 2.8639
Epoch 47/50
530/530 2s 3ms/step - accuracy: 0.1936 - loss: 2.8791 - val_accuracy: 0.1950 - val_loss: 2.6539
Epoch 48/50
530/530 2s 3ms/step - accuracy: 0.1930 - loss: 2.8846 - val_accuracy: 0.2330 - val_loss: 2.7570
Epoch 49/50
530/530 2s 3ms/step - accuracy: 0.1868 - loss: 2.8914 - val_accuracy: 0.2110 - val_loss: 2.7564
Epoch 50/50
530/530 3s 3ms/step - accuracy: 0.1915 - loss: 2.8826 - val_accuracy: 0.2630 - val_loss: 2.5889
Accuracy: 0.2530
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_27"

Layer (type)	Output Shape	Param #
dense_138 (Dense)	(None, 32)	352
batch_normalization_111 (BatchNormalization)	(None, 32)	128
dropout_111 (Dropout)	(None, 32)	0
dense_139 (Dense)	(None, 64)	2,112
batch_normalization_112 (BatchNormalization)	(None, 64)	256
dropout_112 (Dropout)	(None, 64)	0
dense_140 (Dense)	(None, 32)	2,080
batch_normalization_113 (BatchNormalization)	(None, 32)	128
dropout_113 (Dropout)	(None, 32)	0
dense_141 (Dense)	(None, 16)	528
batch_normalization_114 (BatchNormalization)	(None, 16)	64
dropout_114 (Dropout)	(None, 16)	0
dense_142 (Dense)	(None, 32)	544
batch_normalization_115 (BatchNormalization)	(None, 32)	128
dropout_115 (Dropout)	(None, 32)	0
dense_143 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 6s 5ms/step - accuracy: 0.2302 - loss: 2.7664 - val_accuracy: 0.3510 - val_loss: 2.8479
Epoch 2/50
265/265 2s 3ms/step - accuracy: 0.2957 - loss: 2.4599 - val_accuracy: 0.3210 - val_loss: 2.6770
Epoch 3/50
265/265 1s 3ms/step - accuracy: 0.3075 - loss: 2.4468 - val_accuracy: 0.3420 - val_loss: 2.3964
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.3220 - loss: 2.3915 - val_accuracy: 0.3340 - val_loss: 2.4171
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.3336 - loss: 2.3574 - val_accuracy: 0.3490 - val_loss: 2.3555
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.3344 - loss: 2.3599 - val_accuracy: 0.3890 - val_loss: 2.2288
Epoch 7/50
265/265 2s 6ms/step - accuracy: 0.3390 - loss: 2.3394 - val_accuracy: 0.3470 - val_loss: 2.4673
Epoch 8/50
265/265 2s 5ms/step - accuracy: 0.3378 - loss: 2.3744 - val_accuracy: 0.3750 - val_loss: 2.3649
Epoch 9/50
265/265 1s 4ms/step - accuracy: 0.3425 - loss: 2.3607 - val_accuracy: 0.3470 - val_loss: 2.3215
Epoch 10/50
265/265 1s 4ms/step - accuracy: 0.3422 - loss: 2.3542 - val_accuracy: 0.3630 - val_loss: 2.3433
Epoch 11/50
265/265 1s 4ms/step - accuracy: 0.3498 - loss: 2.3094 - val_accuracy: 0.3470 - val_loss: 2.1934
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.3438 - loss: 2.3675 - val_accuracy: 0.3980 - val_loss: 2.1586
Epoch 13/50
265/265 1s 4ms/step - accuracy: 0.3533 - loss: 2.3222 - val_accuracy: 0.3380 - val_loss: 2.2812
Epoch 14/50
265/265 1s 4ms/step - accuracy: 0.3571 - loss: 2.3072 - val_accuracy: 0.4030 - val_loss: 2.1962
Epoch 15/50
265/265 1s 4ms/step - accuracy: 0.3538 - loss: 2.3131 - val_accuracy: 0.3850 - val_loss: 2.2756
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.3622 - loss: 2.3002 - val_accuracy: 0.4110 - val_loss: 2.1164
Epoch 17/50
265/265 2s 6ms/step - accuracy: 0.3618 - loss: 2.2929 - val_accuracy: 0.4160 - val_loss: 2.1845
Epoch 18/50
265/265 3s 5ms/step - accuracy: 0.3620 - loss: 2.3163 - val_accuracy: 0.3770 - val_loss: 2.1955
Epoch 19/50
265/265 2s 4ms/step - accuracy: 0.3690 - loss: 2.2982 - val_accuracy: 0.4380 - val_loss: 2.0555
Epoch 20/50
265/265 1s 4ms/step - accuracy: 0.3620 - loss: 2.2954 - val_accuracy: 0.3880 - val_loss: 2.2467
Epoch 21/50
265/265 1s 4ms/step - accuracy: 0.3604 - loss: 2.3128 - val_accuracy: 0.4460 - val_loss: 2.1156
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.3752 - loss: 2.2702 - val_accuracy: 0.3390 - val_loss: 2.3660
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.3652 - loss: 2.3096 - val_accuracy: 0.4080 - val_loss: 2.1688
Epoch 24/50
265/265 1s 3ms/step - accuracy: 0.3675 - loss: 2.2926 - val_accuracy: 0.4050 - val_loss: 2.0701
Epoch 25/50
265/265 1s 4ms/step - accuracy: 0.3737 - loss: 2.2506 - val_accuracy: 0.3560 - val_loss: 2.2885
Epoch 26/50
265/265 1s 4ms/step - accuracy: 0.3679 - loss: 2.2991 - val_accuracy: 0.3680 - val_loss: 2.2519
Epoch 27/50
265/265 1s 5ms/step - accuracy: 0.3667 - loss: 2.2928 - val_accuracy: 0.4370 - val_loss: 2.1143

```
Epoch 28/50
265/265 3s 5ms/step - accuracy: 0.3596 - loss: 2.2965 - val_accuracy: 0.3890 - val_loss: 2.2290
Epoch 29/50
265/265 1s 4ms/step - accuracy: 0.3742 - loss: 2.2998 - val_accuracy: 0.4170 - val_loss: 2.0911
Epoch 30/50
265/265 1s 4ms/step - accuracy: 0.3709 - loss: 2.2903 - val_accuracy: 0.3600 - val_loss: 2.1725
Epoch 31/50
265/265 1s 4ms/step - accuracy: 0.3676 - loss: 2.2878 - val_accuracy: 0.3080 - val_loss: 2.6122
Epoch 32/50
265/265 1s 4ms/step - accuracy: 0.3798 - loss: 2.2670 - val_accuracy: 0.3540 - val_loss: 2.3831
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.3697 - loss: 2.3140 - val_accuracy: 0.3680 - val_loss: 2.2788
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.3664 - loss: 2.2858 - val_accuracy: 0.3980 - val_loss: 2.1663
Epoch 35/50
265/265 1s 4ms/step - accuracy: 0.3698 - loss: 2.2636 - val_accuracy: 0.4680 - val_loss: 2.0312
Epoch 36/50
265/265 1s 4ms/step - accuracy: 0.3761 - loss: 2.2705 - val_accuracy: 0.3980 - val_loss: 2.1627
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.3787 - loss: 2.2559 - val_accuracy: 0.3920 - val_loss: 2.2693
Epoch 38/50
265/265 2s 5ms/step - accuracy: 0.3792 - loss: 2.2676 - val_accuracy: 0.4150 - val_loss: 2.1272
Epoch 39/50
265/265 2s 6ms/step - accuracy: 0.3703 - loss: 2.2904 - val_accuracy: 0.3770 - val_loss: 2.2312
Epoch 40/50
265/265 1s 5ms/step - accuracy: 0.3757 - loss: 2.2707 - val_accuracy: 0.4220 - val_loss: 2.1716
Epoch 41/50
265/265 2s 4ms/step - accuracy: 0.3841 - loss: 2.2496 - val_accuracy: 0.3540 - val_loss: 2.2061
Epoch 42/50
265/265 1s 4ms/step - accuracy: 0.3745 - loss: 2.3014 - val_accuracy: 0.3640 - val_loss: 2.4481
Epoch 43/50
265/265 1s 4ms/step - accuracy: 0.3859 - loss: 2.2607 - val_accuracy: 0.4260 - val_loss: 2.0817
Epoch 44/50
265/265 1s 4ms/step - accuracy: 0.3680 - loss: 2.3017 - val_accuracy: 0.3700 - val_loss: 2.2178
Epoch 45/50
265/265 1s 4ms/step - accuracy: 0.3859 - loss: 2.2731 - val_accuracy: 0.4260 - val_loss: 2.1190
Epoch 46/50
265/265 1s 4ms/step - accuracy: 0.3807 - loss: 2.2782 - val_accuracy: 0.4360 - val_loss: 2.1410
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.3833 - loss: 2.2482 - val_accuracy: 0.4110 - val_loss: 2.1867
Epoch 48/50
265/265 1s 5ms/step - accuracy: 0.3754 - loss: 2.2779 - val_accuracy: 0.4270 - val_loss: 2.2209
Epoch 49/50
265/265 1s 5ms/step - accuracy: 0.3862 - loss: 2.2469 - val_accuracy: 0.4170 - val_loss: 2.1086
Epoch 50/50
265/265 2s 4ms/step - accuracy: 0.3882 - loss: 2.2385 - val_accuracy: 0.3960 - val_loss: 2.1624
Accuracy: 0.4090
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_28"

Layer (type)	Output Shape	Param #
dense_144 (Dense)	(None, 32)	352
batch_normalization_116 (BatchNormalization)	(None, 32)	128
dropout_116 (Dropout)	(None, 32)	0
dense_145 (Dense)	(None, 64)	2,112
batch_normalization_117 (BatchNormalization)	(None, 64)	256
dropout_117 (Dropout)	(None, 64)	0
dense_146 (Dense)	(None, 32)	2,080
batch_normalization_118 (BatchNormalization)	(None, 32)	128
dropout_118 (Dropout)	(None, 32)	0
dense_147 (Dense)	(None, 16)	528
batch_normalization_119 (BatchNormalization)	(None, 16)	64
dropout_119 (Dropout)	(None, 16)	0
dense_148 (Dense)	(None, 32)	544
batch_normalization_120 (BatchNormalization)	(None, 32)	128
dropout_120 (Dropout)	(None, 32)	0
dense_149 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 7s 5ms/step - accuracy: 0.1819 - loss: 2.9646 - val_accuracy: 0.2160 - val_loss: 2.9670
Epoch 2/50
265/265 1s 4ms/step - accuracy: 0.2401 - loss: 2.6157 - val_accuracy: 0.2140 - val_loss: 2.7058
Epoch 3/50
265/265 1s 5ms/step - accuracy: 0.2434 - loss: 2.6267 - val_accuracy: 0.2500 - val_loss: 2.6213
Epoch 4/50
265/265 2s 6ms/step - accuracy: 0.2505 - loss: 2.6185 - val_accuracy: 0.3410 - val_loss: 2.4186
Epoch 5/50
265/265 2s 4ms/step - accuracy: 0.2666 - loss: 2.5532 - val_accuracy: 0.3310 - val_loss: 2.4611
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.2673 - loss: 2.5649 - val_accuracy: 0.3210 - val_loss: 2.3377
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.2787 - loss: 2.5491 - val_accuracy: 0.3500 - val_loss: 2.3099
Epoch 8/50
265/265 1s 4ms/step - accuracy: 0.2783 - loss: 2.5532 - val_accuracy: 0.3280 - val_loss: 2.3334
Epoch 9/50
265/265 1s 4ms/step - accuracy: 0.2804 - loss: 2.5285 - val_accuracy: 0.3170 - val_loss: 2.4224
Epoch 10/50
265/265 1s 4ms/step - accuracy: 0.2752 - loss: 2.5662 - val_accuracy: 0.3530 - val_loss: 2.3393
Epoch 11/50
265/265 1s 4ms/step - accuracy: 0.2887 - loss: 2.5102 - val_accuracy: 0.3410 - val_loss: 2.3974
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.2814 - loss: 2.5167 - val_accuracy: 0.3330 - val_loss: 2.4507
Epoch 13/50
265/265 1s 5ms/step - accuracy: 0.2846 - loss: 2.5115 - val_accuracy: 0.3390 - val_loss: 2.3478
Epoch 14/50
265/265 2s 6ms/step - accuracy: 0.2908 - loss: 2.5168 - val_accuracy: 0.3730 - val_loss: 2.3398
Epoch 15/50
265/265 2s 6ms/step - accuracy: 0.2882 - loss: 2.5311 - val_accuracy: 0.2720 - val_loss: 2.7846
Epoch 16/50
265/265 1s 5ms/step - accuracy: 0.2905 - loss: 2.5402 - val_accuracy: 0.3830 - val_loss: 2.2808
Epoch 17/50
265/265 1s 4ms/step - accuracy: 0.2970 - loss: 2.5195 - val_accuracy: 0.2810 - val_loss: 2.4925
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.2934 - loss: 2.5247 - val_accuracy: 0.3030 - val_loss: 2.3571
Epoch 19/50
265/265 1s 4ms/step - accuracy: 0.2910 - loss: 2.5144 - val_accuracy: 0.3490 - val_loss: 2.4112
Epoch 20/50
265/265 1s 4ms/step - accuracy: 0.2849 - loss: 2.5281 - val_accuracy: 0.3360 - val_loss: 2.3874
Epoch 21/50
265/265 1s 4ms/step - accuracy: 0.2927 - loss: 2.5219 - val_accuracy: 0.3790 - val_loss: 2.1819
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.3004 - loss: 2.4805 - val_accuracy: 0.3500 - val_loss: 2.3433
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.2990 - loss: 2.5362 - val_accuracy: 0.2890 - val_loss: 2.5158
Epoch 24/50
265/265 1s 4ms/step - accuracy: 0.3073 - loss: 2.4893 - val_accuracy: 0.3500 - val_loss: 2.2327
Epoch 25/50
265/265 2s 5ms/step - accuracy: 0.3030 - loss: 2.4970 - val_accuracy: 0.3450 - val_loss: 2.3622
Epoch 26/50
265/265 3s 6ms/step - accuracy: 0.2934 - loss: 2.5363 - val_accuracy: 0.3060 - val_loss: 2.3956
Epoch 27/50
265/265 1s 5ms/step - accuracy: 0.2948 - loss: 2.5178 - val_accuracy: 0.3500 - val_loss: 2.3851

```
Epoch 28/50
265/265 2s 4ms/step - accuracy: 0.2935 - loss: 2.5164 - val_accuracy: 0.2860 - val_loss: 2.6188
Epoch 29/50
265/265 1s 4ms/step - accuracy: 0.3022 - loss: 2.5096 - val_accuracy: 0.3740 - val_loss: 2.3328
Epoch 30/50
265/265 1s 4ms/step - accuracy: 0.3008 - loss: 2.5245 - val_accuracy: 0.3340 - val_loss: 2.3099
Epoch 31/50
265/265 1s 4ms/step - accuracy: 0.3065 - loss: 2.5290 - val_accuracy: 0.4100 - val_loss: 2.1570
Epoch 32/50
265/265 1s 4ms/step - accuracy: 0.2999 - loss: 2.5020 - val_accuracy: 0.3810 - val_loss: 2.2566
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.3004 - loss: 2.5205 - val_accuracy: 0.3400 - val_loss: 2.4048
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.2971 - loss: 2.5367 - val_accuracy: 0.3330 - val_loss: 2.3539
Epoch 35/50
265/265 1s 5ms/step - accuracy: 0.2900 - loss: 2.5407 - val_accuracy: 0.3140 - val_loss: 2.5005
Epoch 36/50
265/265 3s 6ms/step - accuracy: 0.3037 - loss: 2.5141 - val_accuracy: 0.3360 - val_loss: 2.3127
Epoch 37/50
265/265 2s 4ms/step - accuracy: 0.2963 - loss: 2.4896 - val_accuracy: 0.3820 - val_loss: 2.2715
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.3001 - loss: 2.4908 - val_accuracy: 0.3230 - val_loss: 2.4074
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.2966 - loss: 2.5013 - val_accuracy: 0.3540 - val_loss: 2.3364
Epoch 40/50
265/265 1s 4ms/step - accuracy: 0.3018 - loss: 2.5061 - val_accuracy: 0.3300 - val_loss: 2.3913
Epoch 41/50
265/265 1s 4ms/step - accuracy: 0.3038 - loss: 2.5062 - val_accuracy: 0.3670 - val_loss: 2.2311
Epoch 42/50
265/265 1s 4ms/step - accuracy: 0.3111 - loss: 2.4904 - val_accuracy: 0.3620 - val_loss: 2.2827
Epoch 43/50
265/265 1s 4ms/step - accuracy: 0.3056 - loss: 2.5141 - val_accuracy: 0.3890 - val_loss: 2.2917
Epoch 44/50
265/265 1s 5ms/step - accuracy: 0.3078 - loss: 2.5087 - val_accuracy: 0.3830 - val_loss: 2.2025
Epoch 45/50
265/265 2s 6ms/step - accuracy: 0.3075 - loss: 2.4927 - val_accuracy: 0.3730 - val_loss: 2.2591
Epoch 46/50
265/265 2s 6ms/step - accuracy: 0.3161 - loss: 2.4660 - val_accuracy: 0.3450 - val_loss: 2.3396
Epoch 47/50
265/265 2s 4ms/step - accuracy: 0.3070 - loss: 2.5050 - val_accuracy: 0.3690 - val_loss: 2.3488
Epoch 48/50
265/265 1s 4ms/step - accuracy: 0.3082 - loss: 2.5048 - val_accuracy: 0.4100 - val_loss: 2.2526
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.3036 - loss: 2.5097 - val_accuracy: 0.3770 - val_loss: 2.3539
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.3022 - loss: 2.5117 - val_accuracy: 0.3860 - val_loss: 2.3124
Accuracy: 0.3770
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_29"

Layer (type)	Output Shape	Param #
dense_150 (Dense)	(None, 32)	352
batch_normalization_121 (BatchNormalization)	(None, 32)	128
dropout_121 (Dropout)	(None, 32)	0
dense_151 (Dense)	(None, 64)	2,112
batch_normalization_122 (BatchNormalization)	(None, 64)	256
dropout_122 (Dropout)	(None, 64)	0
dense_152 (Dense)	(None, 32)	2,080
batch_normalization_123 (BatchNormalization)	(None, 32)	128
dropout_123 (Dropout)	(None, 32)	0
dense_153 (Dense)	(None, 16)	528
batch_normalization_124 (BatchNormalization)	(None, 16)	64
dropout_124 (Dropout)	(None, 16)	0
dense_154 (Dense)	(None, 32)	544
batch_normalization_125 (BatchNormalization)	(None, 32)	128
dropout_125 (Dropout)	(None, 32)	0
dense_155 (Dense)	(None, 20)	660

Total params: 6,980 (27.27 KB)

Trainable params: 6,628 (25.89 KB)

Non-trainable params: 352 (1.38 KB)

None
Model compiled.
Epoch 1/50
265/265 6s 7ms/step - accuracy: 0.1458 - loss: 3.0668 - val_accuracy: 0.1870 - val_loss: 2.7679
Epoch 2/50
265/265 2s 6ms/step - accuracy: 0.1904 - loss: 2.7690 - val_accuracy: 0.2000 - val_loss: 2.6431
Epoch 3/50
265/265 1s 5ms/step - accuracy: 0.2032 - loss: 2.7721 - val_accuracy: 0.2100 - val_loss: 2.7980
Epoch 4/50
265/265 1s 4ms/step - accuracy: 0.1931 - loss: 2.7630 - val_accuracy: 0.2920 - val_loss: 2.6222
Epoch 5/50
265/265 1s 4ms/step - accuracy: 0.2134 - loss: 2.7471 - val_accuracy: 0.2310 - val_loss: 2.5261
Epoch 6/50
265/265 1s 4ms/step - accuracy: 0.2122 - loss: 2.7403 - val_accuracy: 0.2700 - val_loss: 2.4969
Epoch 7/50
265/265 1s 4ms/step - accuracy: 0.2226 - loss: 2.6977 - val_accuracy: 0.3000 - val_loss: 2.3506
Epoch 8/50
265/265 1s 4ms/step - accuracy: 0.2200 - loss: 2.7013 - val_accuracy: 0.2770 - val_loss: 2.4976
Epoch 9/50
265/265 1s 4ms/step - accuracy: 0.2281 - loss: 2.7009 - val_accuracy: 0.2890 - val_loss: 2.5185
Epoch 10/50
265/265 1s 4ms/step - accuracy: 0.2225 - loss: 2.7505 - val_accuracy: 0.2100 - val_loss: 2.5921
Epoch 11/50
265/265 1s 4ms/step - accuracy: 0.2304 - loss: 2.6841 - val_accuracy: 0.2870 - val_loss: 2.5642
Epoch 12/50
265/265 1s 4ms/step - accuracy: 0.2229 - loss: 2.7236 - val_accuracy: 0.2960 - val_loss: 2.4623
Epoch 13/50
265/265 1s 5ms/step - accuracy: 0.2363 - loss: 2.6643 - val_accuracy: 0.2860 - val_loss: 2.4948
Epoch 14/50
265/265 2s 6ms/step - accuracy: 0.2362 - loss: 2.7072 - val_accuracy: 0.2260 - val_loss: 2.5876
Epoch 15/50
265/265 2s 4ms/step - accuracy: 0.2236 - loss: 2.7129 - val_accuracy: 0.2770 - val_loss: 2.5634
Epoch 16/50
265/265 1s 4ms/step - accuracy: 0.2303 - loss: 2.6645 - val_accuracy: 0.2690 - val_loss: 2.6255
Epoch 17/50
265/265 1s 4ms/step - accuracy: 0.2294 - loss: 2.6946 - val_accuracy: 0.2320 - val_loss: 2.6450
Epoch 18/50
265/265 1s 4ms/step - accuracy: 0.2335 - loss: 2.6817 - val_accuracy: 0.2910 - val_loss: 2.3833
Epoch 19/50
265/265 1s 4ms/step - accuracy: 0.2281 - loss: 2.7225 - val_accuracy: 0.2900 - val_loss: 2.5074
Epoch 20/50
265/265 1s 4ms/step - accuracy: 0.2310 - loss: 2.6914 - val_accuracy: 0.2940 - val_loss: 2.4766
Epoch 21/50
265/265 1s 4ms/step - accuracy: 0.2407 - loss: 2.6819 - val_accuracy: 0.2440 - val_loss: 2.4456
Epoch 22/50
265/265 1s 4ms/step - accuracy: 0.2368 - loss: 2.6694 - val_accuracy: 0.2100 - val_loss: 2.4603
Epoch 23/50
265/265 1s 4ms/step - accuracy: 0.2388 - loss: 2.6893 - val_accuracy: 0.3310 - val_loss: 2.3677
Epoch 24/50
265/265 2s 5ms/step - accuracy: 0.2300 - loss: 2.6833 - val_accuracy: 0.2600 - val_loss: 2.6282
Epoch 25/50
265/265 2s 5ms/step - accuracy: 0.2317 - loss: 2.7051 - val_accuracy: 0.2800 - val_loss: 2.4753
Epoch 26/50
265/265 2s 5ms/step - accuracy: 0.2296 - loss: 2.7001 - val_accuracy: 0.3220 - val_loss: 2.4320
Epoch 27/50
265/265 2s 4ms/step - accuracy: 0.2330 - loss: 2.6756 - val_accuracy: 0.2590 - val_loss: 2.5363

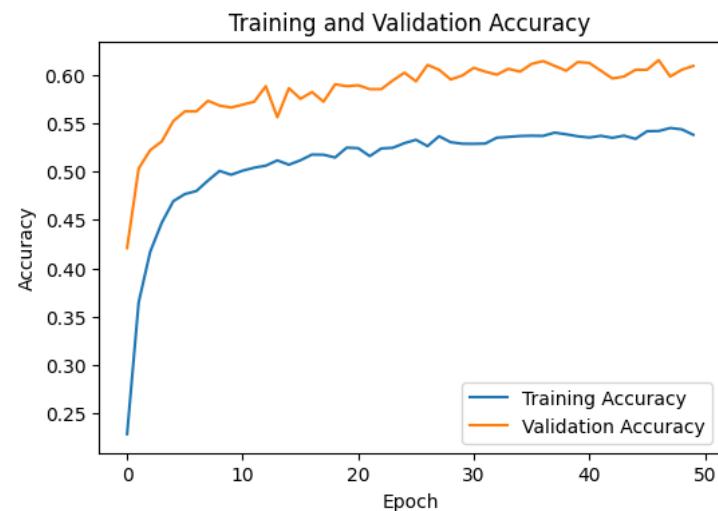
```
Epoch 28/50
265/265 1s 4ms/step - accuracy: 0.2399 - loss: 2.6944 - val_accuracy: 0.2650 - val_loss: 2.5416
Epoch 29/50
265/265 1s 4ms/step - accuracy: 0.2306 - loss: 2.6834 - val_accuracy: 0.2450 - val_loss: 2.4926
Epoch 30/50
265/265 1s 4ms/step - accuracy: 0.2392 - loss: 2.6781 - val_accuracy: 0.2710 - val_loss: 2.5196
Epoch 31/50
265/265 1s 4ms/step - accuracy: 0.2438 - loss: 2.6707 - val_accuracy: 0.3120 - val_loss: 2.5309
Epoch 32/50
265/265 1s 4ms/step - accuracy: 0.2466 - loss: 2.6869 - val_accuracy: 0.3150 - val_loss: 2.4244
Epoch 33/50
265/265 1s 4ms/step - accuracy: 0.2394 - loss: 2.6556 - val_accuracy: 0.2910 - val_loss: 2.4420
Epoch 34/50
265/265 1s 4ms/step - accuracy: 0.2421 - loss: 2.6819 - val_accuracy: 0.2910 - val_loss: 2.4573
Epoch 35/50
265/265 2s 6ms/step - accuracy: 0.2355 - loss: 2.6741 - val_accuracy: 0.3510 - val_loss: 2.3192
Epoch 36/50
265/265 2s 4ms/step - accuracy: 0.2384 - loss: 2.6706 - val_accuracy: 0.2700 - val_loss: 2.5695
Epoch 37/50
265/265 1s 4ms/step - accuracy: 0.2409 - loss: 2.6931 - val_accuracy: 0.3340 - val_loss: 2.4139
Epoch 38/50
265/265 1s 4ms/step - accuracy: 0.2527 - loss: 2.6535 - val_accuracy: 0.3150 - val_loss: 2.4267
Epoch 39/50
265/265 1s 4ms/step - accuracy: 0.2417 - loss: 2.6815 - val_accuracy: 0.2880 - val_loss: 2.5729
Epoch 40/50
265/265 1s 4ms/step - accuracy: 0.2549 - loss: 2.6503 - val_accuracy: 0.2380 - val_loss: 2.5912
Epoch 41/50
265/265 1s 4ms/step - accuracy: 0.2392 - loss: 2.6919 - val_accuracy: 0.2620 - val_loss: 2.5023
Epoch 42/50
265/265 1s 4ms/step - accuracy: 0.2345 - loss: 2.6772 - val_accuracy: 0.2630 - val_loss: 2.4882
Epoch 43/50
265/265 1s 4ms/step - accuracy: 0.2548 - loss: 2.6647 - val_accuracy: 0.2810 - val_loss: 2.4213
Epoch 44/50
265/265 1s 5ms/step - accuracy: 0.2481 - loss: 2.6721 - val_accuracy: 0.2750 - val_loss: 2.4581
Epoch 45/50
265/265 1s 5ms/step - accuracy: 0.2418 - loss: 2.6819 - val_accuracy: 0.2980 - val_loss: 2.4543
Epoch 46/50
265/265 2s 4ms/step - accuracy: 0.2462 - loss: 2.6797 - val_accuracy: 0.2750 - val_loss: 2.4565
Epoch 47/50
265/265 1s 4ms/step - accuracy: 0.2411 - loss: 2.6812 - val_accuracy: 0.3060 - val_loss: 2.4075
Epoch 48/50
265/265 1s 4ms/step - accuracy: 0.2469 - loss: 2.6560 - val_accuracy: 0.2900 - val_loss: 2.4483
Epoch 49/50
265/265 1s 4ms/step - accuracy: 0.2384 - loss: 2.6823 - val_accuracy: 0.3060 - val_loss: 2.4029
Epoch 50/50
265/265 1s 4ms/step - accuracy: 0.2526 - loss: 2.6440 - val_accuracy: 0.3000 - val_loss: 2.4628
Accuracy: 0.2825
```

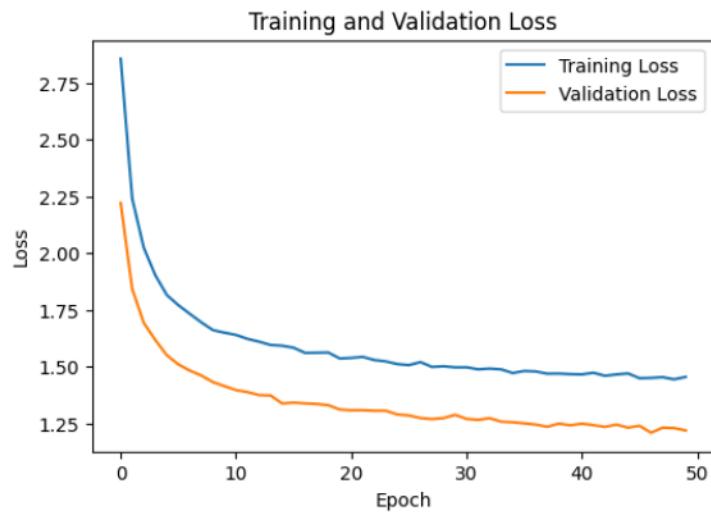
```
Best Hyperparameters:
{'learning_rate': 0.001, 'batch_size': 64, 'dropout': 0.1}
Best Accuracy: 0.6040
```

```
In [ ]: plt.figure(figsize=(6, 4))
plt.plot(best_history.history['accuracy'], label='Training Accuracy')
plt.plot(best_history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Training and Validation Accuracy')
```

```
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

plt.figure(figsize=(6, 4))
plt.plot(best_history.history['loss'], label='Training Loss')
plt.plot(best_history.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```





```
In [ ]: best_model.evaluate(X_test, y_test)
63/63  _____ 0s 1ms/step - accuracy: 0.6100 - loss: 1.2808
[1.27437162399292, 0.6039999723434448]
Out[ ]:
```

10 Layer Neural Network

```
In [ ]: learning_rates = [0.001, 0.01, 0.0001]
batch_sizes = [32, 64]
dropout = [0.1, 0.2]
best_accuracy = 0
input_shape = X_train.shape[1:]
best_history = None
best_model = None

for lr in learning_rates:
    for batch in batch_sizes:
        for d in dropout:
            model = Ten_Layer_NN()
            config = {
                'input_shape': input_shape,
                'epochs': 50,
                'dropout': d,
                'batch_size': batch,
                'lr': lr
            }
            model.build_model(config)
            history = model.train(X_train, y_train, X_valid, y_valid, config)
            loss, accuracy = model.evaluate(X_test, y_test, verbose=0)
```

```
print(f"Accuracy: {accuracy:.4f}")

if accuracy > best_accuracy:
    best_model = model
    best_accuracy = accuracy
    best_params = {'learning_rate': lr, 'batch_size': batch, 'dropout': d}
    best_history = history

print("\nBest Hyperparameters:")
print(best_params)
print(f"Best Accuracy: {best_accuracy:.4f}")

/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
Argument `decay` is no longer supported and will be ignored.

Model: "sequential_30"
```

Layer (type)	Output Shape	Param #
dense_156 (Dense)	(None, 32)	352
batch_normalization_126 (BatchNormalization)	(None, 32)	128
dropout_126 (Dropout)	(None, 32)	0
dense_157 (Dense)	(None, 64)	2,112
batch_normalization_127 (BatchNormalization)	(None, 64)	256
dropout_127 (Dropout)	(None, 64)	0
dense_158 (Dense)	(None, 128)	8,320
batch_normalization_128 (BatchNormalization)	(None, 128)	512
dropout_128 (Dropout)	(None, 128)	0
dense_159 (Dense)	(None, 64)	8,256
batch_normalization_129 (BatchNormalization)	(None, 64)	256
dropout_129 (Dropout)	(None, 64)	0
dense_160 (Dense)	(None, 32)	2,080
batch_normalization_130 (BatchNormalization)	(None, 32)	128
dense_161 (Dense)	(None, 16)	528
batch_normalization_131 (BatchNormalization)	(None, 16)	64
dropout_130 (Dropout)	(None, 16)	0
dense_162 (Dense)	(None, 8)	136
batch_normalization_132 (BatchNormalization)	(None, 8)	32
dropout_131 (Dropout)	(None, 8)	0
dense_163 (Dense)	(None, 16)	144
batch_normalization_133 (BatchNormalization)	(None, 16)	64
dropout_132 (Dropout)	(None, 16)	0

dense_164 (Dense)	(None, 32)	544
batch_normalization_134 (BatchNormalization)	(None, 32)	128
dropout_133 (Dropout)	(None, 32)	0
dense_165 (Dense)	(None, 20)	660

Total params: 24,700 (96.48 KB)

Trainable params: 23,916 (93.42 KB)

Non-trainable params: 784 (3.06 KB)

None
Model compiled.
Epoch 1/50
530/530 11s 5ms/step - accuracy: 0.1039 - loss: 3.4464 - val_accuracy: 0.2840 - val_loss: 2.4897
Epoch 2/50
530/530 3s 5ms/step - accuracy: 0.2492 - loss: 2.6182 - val_accuracy: 0.4170 - val_loss: 2.0357
Epoch 3/50
530/530 2s 5ms/step - accuracy: 0.3261 - loss: 2.3207 - val_accuracy: 0.4690 - val_loss: 1.8317
Epoch 4/50
530/530 3s 6ms/step - accuracy: 0.3502 - loss: 2.1546 - val_accuracy: 0.5010 - val_loss: 1.7345
Epoch 5/50
530/530 4s 5ms/step - accuracy: 0.3849 - loss: 2.0567 - val_accuracy: 0.5110 - val_loss: 1.6658
Epoch 6/50
530/530 3s 5ms/step - accuracy: 0.3992 - loss: 2.0023 - val_accuracy: 0.5320 - val_loss: 1.6228
Epoch 7/50
530/530 2s 5ms/step - accuracy: 0.4141 - loss: 1.9537 - val_accuracy: 0.5250 - val_loss: 1.5884
Epoch 8/50
530/530 3s 6ms/step - accuracy: 0.4233 - loss: 1.9103 - val_accuracy: 0.5440 - val_loss: 1.5505
Epoch 9/50
530/530 5s 5ms/step - accuracy: 0.4312 - loss: 1.9019 - val_accuracy: 0.5330 - val_loss: 1.5383
Epoch 10/50
530/530 2s 5ms/step - accuracy: 0.4222 - loss: 1.8930 - val_accuracy: 0.5320 - val_loss: 1.5470
Epoch 11/50
530/530 3s 5ms/step - accuracy: 0.4410 - loss: 1.8471 - val_accuracy: 0.5570 - val_loss: 1.4872
Epoch 12/50
530/530 3s 6ms/step - accuracy: 0.4461 - loss: 1.8355 - val_accuracy: 0.5490 - val_loss: 1.4795
Epoch 13/50
530/530 4s 5ms/step - accuracy: 0.4371 - loss: 1.8276 - val_accuracy: 0.5490 - val_loss: 1.4698
Epoch 14/50
530/530 3s 5ms/step - accuracy: 0.4383 - loss: 1.8025 - val_accuracy: 0.5380 - val_loss: 1.4755
Epoch 15/50
530/530 2s 5ms/step - accuracy: 0.4528 - loss: 1.8145 - val_accuracy: 0.5710 - val_loss: 1.4260
Epoch 16/50
530/530 3s 6ms/step - accuracy: 0.4659 - loss: 1.7594 - val_accuracy: 0.5720 - val_loss: 1.4509
Epoch 17/50
530/530 4s 5ms/step - accuracy: 0.4570 - loss: 1.7733 - val_accuracy: 0.5650 - val_loss: 1.4346
Epoch 18/50
530/530 2s 5ms/step - accuracy: 0.4584 - loss: 1.7681 - val_accuracy: 0.5780 - val_loss: 1.4008
Epoch 19/50
530/530 3s 5ms/step - accuracy: 0.4688 - loss: 1.7373 - val_accuracy: 0.5720 - val_loss: 1.4109
Epoch 20/50
530/530 3s 6ms/step - accuracy: 0.4712 - loss: 1.7185 - val_accuracy: 0.5880 - val_loss: 1.3932
Epoch 21/50
530/530 4s 7ms/step - accuracy: 0.4671 - loss: 1.7493 - val_accuracy: 0.5900 - val_loss: 1.3801
Epoch 22/50
530/530 2s 5ms/step - accuracy: 0.4753 - loss: 1.7252 - val_accuracy: 0.5820 - val_loss: 1.3882
Epoch 23/50
530/530 3s 5ms/step - accuracy: 0.4697 - loss: 1.7282 - val_accuracy: 0.5900 - val_loss: 1.3481
Epoch 24/50
530/530 2s 5ms/step - accuracy: 0.4661 - loss: 1.7234 - val_accuracy: 0.5690 - val_loss: 1.3726
Epoch 25/50
530/530 3s 5ms/step - accuracy: 0.4702 - loss: 1.7319 - val_accuracy: 0.5930 - val_loss: 1.3497
Epoch 26/50
530/530 4s 7ms/step - accuracy: 0.4732 - loss: 1.7120 - val_accuracy: 0.5900 - val_loss: 1.3500
Epoch 27/50
530/530 2s 5ms/step - accuracy: 0.4810 - loss: 1.6979 - val_accuracy: 0.5940 - val_loss: 1.3350

```
Epoch 28/50
530/530 2s 5ms/step - accuracy: 0.4798 - loss: 1.6902 - val_accuracy: 0.6090 - val_loss: 1.3314
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.4837 - loss: 1.6870 - val_accuracy: 0.5900 - val_loss: 1.3563
Epoch 30/50
530/530 3s 6ms/step - accuracy: 0.4778 - loss: 1.6811 - val_accuracy: 0.5940 - val_loss: 1.3228
Epoch 31/50
530/530 5s 5ms/step - accuracy: 0.4803 - loss: 1.6812 - val_accuracy: 0.6010 - val_loss: 1.3133
Epoch 32/50
530/530 3s 5ms/step - accuracy: 0.4863 - loss: 1.6688 - val_accuracy: 0.5820 - val_loss: 1.3444
Epoch 33/50
530/530 3s 5ms/step - accuracy: 0.4838 - loss: 1.6928 - val_accuracy: 0.5920 - val_loss: 1.3244
Epoch 34/50
530/530 6s 6ms/step - accuracy: 0.4907 - loss: 1.6616 - val_accuracy: 0.5930 - val_loss: 1.3040
Epoch 35/50
530/530 4s 5ms/step - accuracy: 0.4980 - loss: 1.6510 - val_accuracy: 0.5940 - val_loss: 1.3041
Epoch 36/50
530/530 2s 5ms/step - accuracy: 0.4800 - loss: 1.6734 - val_accuracy: 0.6020 - val_loss: 1.3117
Epoch 37/50
530/530 3s 5ms/step - accuracy: 0.4881 - loss: 1.6577 - val_accuracy: 0.5950 - val_loss: 1.3177
Epoch 38/50
530/530 5s 5ms/step - accuracy: 0.4961 - loss: 1.6319 - val_accuracy: 0.5710 - val_loss: 1.3279
Epoch 39/50
530/530 3s 5ms/step - accuracy: 0.4893 - loss: 1.6733 - val_accuracy: 0.6010 - val_loss: 1.2955
Epoch 40/50
530/530 6s 6ms/step - accuracy: 0.4844 - loss: 1.6577 - val_accuracy: 0.5920 - val_loss: 1.3072
Epoch 41/50
530/530 4s 7ms/step - accuracy: 0.4828 - loss: 1.6576 - val_accuracy: 0.5820 - val_loss: 1.3053
Epoch 42/50
530/530 4s 5ms/step - accuracy: 0.4982 - loss: 1.6417 - val_accuracy: 0.5970 - val_loss: 1.3006
Epoch 43/50
530/530 3s 5ms/step - accuracy: 0.4992 - loss: 1.6378 - val_accuracy: 0.5960 - val_loss: 1.2906
Epoch 44/50
530/530 3s 5ms/step - accuracy: 0.4960 - loss: 1.6298 - val_accuracy: 0.5890 - val_loss: 1.3109
Epoch 45/50
530/530 4s 8ms/step - accuracy: 0.4932 - loss: 1.6437 - val_accuracy: 0.6020 - val_loss: 1.2907
Epoch 46/50
530/530 3s 5ms/step - accuracy: 0.4982 - loss: 1.6168 - val_accuracy: 0.5920 - val_loss: 1.2973
Epoch 47/50
530/530 5s 5ms/step - accuracy: 0.4953 - loss: 1.6358 - val_accuracy: 0.5950 - val_loss: 1.2814
Epoch 48/50
530/530 3s 5ms/step - accuracy: 0.5017 - loss: 1.6193 - val_accuracy: 0.5890 - val_loss: 1.2962
Epoch 49/50
530/530 5s 5ms/step - accuracy: 0.4981 - loss: 1.6259 - val_accuracy: 0.5960 - val_loss: 1.2847
Epoch 50/50
530/530 3s 5ms/step - accuracy: 0.4965 - loss: 1.6360 - val_accuracy: 0.5820 - val_loss: 1.3218
Accuracy: 0.5735
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_31"

Layer (type)	Output Shape	Param #
dense_166 (Dense)	(None, 32)	352
batch_normalization_135 (BatchNormalization)	(None, 32)	128
dropout_134 (Dropout)	(None, 32)	0
dense_167 (Dense)	(None, 64)	2,112
batch_normalization_136 (BatchNormalization)	(None, 64)	256
dropout_135 (Dropout)	(None, 64)	0
dense_168 (Dense)	(None, 128)	8,320
batch_normalization_137 (BatchNormalization)	(None, 128)	512
dropout_136 (Dropout)	(None, 128)	0
dense_169 (Dense)	(None, 64)	8,256
batch_normalization_138 (BatchNormalization)	(None, 64)	256
dropout_137 (Dropout)	(None, 64)	0
dense_170 (Dense)	(None, 32)	2,080
batch_normalization_139 (BatchNormalization)	(None, 32)	128
dense_171 (Dense)	(None, 16)	528
batch_normalization_140 (BatchNormalization)	(None, 16)	64
dropout_138 (Dropout)	(None, 16)	0
dense_172 (Dense)	(None, 8)	136
batch_normalization_141 (BatchNormalization)	(None, 8)	32
dropout_139 (Dropout)	(None, 8)	0
dense_173 (Dense)	(None, 16)	144
batch_normalization_142 (BatchNormalization)	(None, 16)	64
dropout_140 (Dropout)	(None, 16)	0

dense_174 (Dense)	(None, 32)	544
batch_normalization_143 (BatchNormalization)	(None, 32)	128
dropout_141 (Dropout)	(None, 32)	0
dense_175 (Dense)	(None, 20)	660

Total params: 24,700 (96.48 KB)

Trainable params: 23,916 (93.42 KB)

Non-trainable params: 784 (3.06 KB)

None
Model compiled.
Epoch 1/50
530/530 11s 5ms/step - accuracy: 0.0652 - loss: 3.6193 - val_accuracy: 0.2160 - val_loss: 2.6899
Epoch 2/50
530/530 5s 5ms/step - accuracy: 0.1364 - loss: 2.8716 - val_accuracy: 0.2640 - val_loss: 2.4207
Epoch 3/50
530/530 3s 5ms/step - accuracy: 0.1969 - loss: 2.6125 - val_accuracy: 0.3030 - val_loss: 2.2435
Epoch 4/50
530/530 4s 7ms/step - accuracy: 0.2173 - loss: 2.4785 - val_accuracy: 0.3220 - val_loss: 2.1304
Epoch 5/50
530/530 4s 5ms/step - accuracy: 0.2494 - loss: 2.3779 - val_accuracy: 0.3550 - val_loss: 2.0285
Epoch 6/50
530/530 2s 5ms/step - accuracy: 0.2502 - loss: 2.3063 - val_accuracy: 0.3630 - val_loss: 1.9734
Epoch 7/50
530/530 2s 5ms/step - accuracy: 0.2790 - loss: 2.2437 - val_accuracy: 0.4030 - val_loss: 1.8944
Epoch 8/50
530/530 4s 7ms/step - accuracy: 0.2960 - loss: 2.2006 - val_accuracy: 0.4170 - val_loss: 1.8358
Epoch 9/50
530/530 3s 6ms/step - accuracy: 0.2993 - loss: 2.1694 - val_accuracy: 0.4350 - val_loss: 1.8128
Epoch 10/50
530/530 5s 5ms/step - accuracy: 0.3007 - loss: 2.1665 - val_accuracy: 0.4390 - val_loss: 1.7946
Epoch 11/50
530/530 3s 5ms/step - accuracy: 0.3220 - loss: 2.1210 - val_accuracy: 0.4250 - val_loss: 1.7651
Epoch 12/50
530/530 3s 6ms/step - accuracy: 0.3231 - loss: 2.1034 - val_accuracy: 0.4710 - val_loss: 1.7243
Epoch 13/50
530/530 4s 5ms/step - accuracy: 0.3349 - loss: 2.0818 - val_accuracy: 0.4320 - val_loss: 1.7344
Epoch 14/50
530/530 3s 5ms/step - accuracy: 0.3309 - loss: 2.0938 - val_accuracy: 0.4590 - val_loss: 1.6916
Epoch 15/50
530/530 3s 5ms/step - accuracy: 0.3310 - loss: 2.0755 - val_accuracy: 0.4690 - val_loss: 1.6853
Epoch 16/50
530/530 3s 6ms/step - accuracy: 0.3380 - loss: 2.0558 - val_accuracy: 0.4670 - val_loss: 1.6923
Epoch 17/50
530/530 4s 5ms/step - accuracy: 0.3571 - loss: 2.0320 - val_accuracy: 0.4640 - val_loss: 1.6624
Epoch 18/50
530/530 3s 5ms/step - accuracy: 0.3522 - loss: 2.0347 - val_accuracy: 0.4770 - val_loss: 1.6580
Epoch 19/50
530/530 3s 5ms/step - accuracy: 0.3583 - loss: 2.0143 - val_accuracy: 0.4940 - val_loss: 1.6258
Epoch 20/50
530/530 6s 6ms/step - accuracy: 0.3540 - loss: 2.0216 - val_accuracy: 0.4810 - val_loss: 1.6305
Epoch 21/50
530/530 2s 5ms/step - accuracy: 0.3659 - loss: 2.0059 - val_accuracy: 0.5010 - val_loss: 1.6323
Epoch 22/50
530/530 3s 5ms/step - accuracy: 0.3700 - loss: 1.9992 - val_accuracy: 0.5090 - val_loss: 1.6017
Epoch 23/50
530/530 6s 7ms/step - accuracy: 0.3678 - loss: 1.9924 - val_accuracy: 0.4880 - val_loss: 1.5810
Epoch 24/50
530/530 3s 6ms/step - accuracy: 0.3737 - loss: 1.9745 - val_accuracy: 0.5060 - val_loss: 1.6082
Epoch 25/50
530/530 3s 5ms/step - accuracy: 0.3771 - loss: 1.9779 - val_accuracy: 0.5130 - val_loss: 1.5856
Epoch 26/50
530/530 3s 5ms/step - accuracy: 0.3727 - loss: 1.9790 - val_accuracy: 0.5150 - val_loss: 1.5969
Epoch 27/50
530/530 2s 5ms/step - accuracy: 0.3794 - loss: 1.9632 - val_accuracy: 0.5200 - val_loss: 1.5693

```
Epoch 28/50
530/530 ━━━━━━━━ 4s 7ms/step - accuracy: 0.3746 - loss: 1.9693 - val_accuracy: 0.5020 - val_loss: 1.5882
Epoch 29/50
530/530 ━━━━━━ 4s 5ms/step - accuracy: 0.3766 - loss: 1.9604 - val_accuracy: 0.5110 - val_loss: 1.5553
Epoch 30/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.3856 - loss: 1.9331 - val_accuracy: 0.5290 - val_loss: 1.5361
Epoch 31/50
530/530 ━━━━ 2s 5ms/step - accuracy: 0.3863 - loss: 1.9434 - val_accuracy: 0.5260 - val_loss: 1.5274
Epoch 32/50
530/530 ━━━━ 3s 6ms/step - accuracy: 0.3951 - loss: 1.9275 - val_accuracy: 0.5140 - val_loss: 1.5341
Epoch 33/50
530/530 ━━━━ 4s 5ms/step - accuracy: 0.3883 - loss: 1.9496 - val_accuracy: 0.5400 - val_loss: 1.5324
Epoch 34/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.3878 - loss: 1.9355 - val_accuracy: 0.5410 - val_loss: 1.5319
Epoch 35/50
530/530 ━━━━ 6s 6ms/step - accuracy: 0.3900 - loss: 1.9399 - val_accuracy: 0.5180 - val_loss: 1.5051
Epoch 36/50
530/530 ━━━━ 4s 7ms/step - accuracy: 0.3984 - loss: 1.9106 - val_accuracy: 0.5530 - val_loss: 1.4851
Epoch 37/50
530/530 ━━━━ 4s 5ms/step - accuracy: 0.3987 - loss: 1.9188 - val_accuracy: 0.5280 - val_loss: 1.5098
Epoch 38/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.3969 - loss: 1.9387 - val_accuracy: 0.5410 - val_loss: 1.5139
Epoch 39/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.4027 - loss: 1.9159 - val_accuracy: 0.5360 - val_loss: 1.5084
Epoch 40/50
530/530 ━━━━ 4s 8ms/step - accuracy: 0.4081 - loss: 1.9149 - val_accuracy: 0.5380 - val_loss: 1.5132
Epoch 41/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.4005 - loss: 1.9038 - val_accuracy: 0.5460 - val_loss: 1.4955
Epoch 42/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.4034 - loss: 1.9232 - val_accuracy: 0.5500 - val_loss: 1.4913
Epoch 43/50
530/530 ━━━━ 5s 5ms/step - accuracy: 0.4035 - loss: 1.9145 - val_accuracy: 0.5280 - val_loss: 1.5002
Epoch 44/50
530/530 ━━━━ 4s 8ms/step - accuracy: 0.4031 - loss: 1.9040 - val_accuracy: 0.5330 - val_loss: 1.5085
Epoch 45/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.4053 - loss: 1.8867 - val_accuracy: 0.5450 - val_loss: 1.4821
Epoch 46/50
530/530 ━━━━ 5s 5ms/step - accuracy: 0.4135 - loss: 1.8904 - val_accuracy: 0.5500 - val_loss: 1.4905
Epoch 47/50
530/530 ━━━━ 6s 7ms/step - accuracy: 0.4107 - loss: 1.8913 - val_accuracy: 0.5410 - val_loss: 1.4816
Epoch 48/50
530/530 ━━━━ 4s 5ms/step - accuracy: 0.4118 - loss: 1.9111 - val_accuracy: 0.5550 - val_loss: 1.4687
Epoch 49/50
530/530 ━━━━ 3s 5ms/step - accuracy: 0.4155 - loss: 1.8979 - val_accuracy: 0.5530 - val_loss: 1.4780
Epoch 50/50
530/530 ━━━━ 6s 7ms/step - accuracy: 0.4107 - loss: 1.8992 - val_accuracy: 0.5520 - val_loss: 1.4823
Accuracy: 0.5465
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_32"

Layer (type)	Output Shape	Param #
dense_176 (Dense)	(None, 32)	352
batch_normalization_144 (BatchNormalization)	(None, 32)	128
dropout_142 (Dropout)	(None, 32)	0
dense_177 (Dense)	(None, 64)	2,112
batch_normalization_145 (BatchNormalization)	(None, 64)	256
dropout_143 (Dropout)	(None, 64)	0
dense_178 (Dense)	(None, 128)	8,320
batch_normalization_146 (BatchNormalization)	(None, 128)	512
dropout_144 (Dropout)	(None, 128)	0
dense_179 (Dense)	(None, 64)	8,256
batch_normalization_147 (BatchNormalization)	(None, 64)	256
dropout_145 (Dropout)	(None, 64)	0
dense_180 (Dense)	(None, 32)	2,080
batch_normalization_148 (BatchNormalization)	(None, 32)	128
dense_181 (Dense)	(None, 16)	528
batch_normalization_149 (BatchNormalization)	(None, 16)	64
dropout_146 (Dropout)	(None, 16)	0
dense_182 (Dense)	(None, 8)	136
batch_normalization_150 (BatchNormalization)	(None, 8)	32
dropout_147 (Dropout)	(None, 8)	0
dense_183 (Dense)	(None, 16)	144
batch_normalization_151 (BatchNormalization)	(None, 16)	64
dropout_148 (Dropout)	(None, 16)	0

dense_184 (Dense)	(None, 32)	544
batch_normalization_152 (BatchNormalization)	(None, 32)	128
dropout_149 (Dropout)	(None, 32)	0
dense_185 (Dense)	(None, 20)	660

Total params: 24,700 (96.48 KB)

Trainable params: 23,916 (93.42 KB)

Non-trainable params: 784 (3.06 KB)

None
Model compiled.
Epoch 1/50
265/265 9s 7ms/step - accuracy: 0.0837 - loss: 3.4780 - val_accuracy: 0.2820 - val_loss: 2.5967
Epoch 2/50
265/265 3s 8ms/step - accuracy: 0.2366 - loss: 2.6812 - val_accuracy: 0.3750 - val_loss: 2.1362
Epoch 3/50
265/265 2s 5ms/step - accuracy: 0.3069 - loss: 2.3918 - val_accuracy: 0.4480 - val_loss: 1.9425
Epoch 4/50
265/265 3s 5ms/step - accuracy: 0.3446 - loss: 2.2142 - val_accuracy: 0.4790 - val_loss: 1.8183
Epoch 5/50
265/265 2s 5ms/step - accuracy: 0.3786 - loss: 2.1020 - val_accuracy: 0.5040 - val_loss: 1.7367
Epoch 6/50
265/265 3s 5ms/step - accuracy: 0.3948 - loss: 2.0290 - val_accuracy: 0.5150 - val_loss: 1.6753
Epoch 7/50
265/265 2s 6ms/step - accuracy: 0.4021 - loss: 1.9782 - val_accuracy: 0.5290 - val_loss: 1.6197
Epoch 8/50
265/265 2s 8ms/step - accuracy: 0.4242 - loss: 1.9354 - val_accuracy: 0.5350 - val_loss: 1.5907
Epoch 9/50
265/265 2s 5ms/step - accuracy: 0.4277 - loss: 1.8975 - val_accuracy: 0.5400 - val_loss: 1.5364
Epoch 10/50
265/265 2s 5ms/step - accuracy: 0.4424 - loss: 1.8506 - val_accuracy: 0.5440 - val_loss: 1.5290
Epoch 11/50
265/265 3s 5ms/step - accuracy: 0.4409 - loss: 1.8281 - val_accuracy: 0.5480 - val_loss: 1.4947
Epoch 12/50
265/265 1s 5ms/step - accuracy: 0.4509 - loss: 1.8189 - val_accuracy: 0.5590 - val_loss: 1.4766
Epoch 13/50
265/265 1s 5ms/step - accuracy: 0.4532 - loss: 1.7794 - val_accuracy: 0.5680 - val_loss: 1.4700
Epoch 14/50
265/265 2s 7ms/step - accuracy: 0.4589 - loss: 1.7861 - val_accuracy: 0.5700 - val_loss: 1.4582
Epoch 15/50
265/265 3s 8ms/step - accuracy: 0.4760 - loss: 1.7476 - val_accuracy: 0.5810 - val_loss: 1.4343
Epoch 16/50
265/265 2s 5ms/step - accuracy: 0.4716 - loss: 1.7396 - val_accuracy: 0.5740 - val_loss: 1.4221
Epoch 17/50
265/265 1s 5ms/step - accuracy: 0.4709 - loss: 1.7504 - val_accuracy: 0.5480 - val_loss: 1.4455
Epoch 18/50
265/265 1s 5ms/step - accuracy: 0.4780 - loss: 1.7185 - val_accuracy: 0.5710 - val_loss: 1.4039
Epoch 19/50
265/265 1s 5ms/step - accuracy: 0.4828 - loss: 1.7050 - val_accuracy: 0.5920 - val_loss: 1.3790
Epoch 20/50
265/265 1s 5ms/step - accuracy: 0.4863 - loss: 1.6852 - val_accuracy: 0.5840 - val_loss: 1.3842
Epoch 21/50
265/265 3s 6ms/step - accuracy: 0.4851 - loss: 1.6964 - val_accuracy: 0.5780 - val_loss: 1.3581
Epoch 22/50
265/265 2s 8ms/step - accuracy: 0.4976 - loss: 1.6663 - val_accuracy: 0.5930 - val_loss: 1.3692
Epoch 23/50
265/265 2s 6ms/step - accuracy: 0.4986 - loss: 1.6645 - val_accuracy: 0.5810 - val_loss: 1.3694
Epoch 24/50
265/265 2s 5ms/step - accuracy: 0.5007 - loss: 1.6570 - val_accuracy: 0.5730 - val_loss: 1.3621
Epoch 25/50
265/265 2s 5ms/step - accuracy: 0.4966 - loss: 1.6625 - val_accuracy: 0.5810 - val_loss: 1.3647
Epoch 26/50
265/265 3s 5ms/step - accuracy: 0.4948 - loss: 1.6372 - val_accuracy: 0.5820 - val_loss: 1.3597
Epoch 27/50
265/265 1s 5ms/step - accuracy: 0.5065 - loss: 1.6247 - val_accuracy: 0.5980 - val_loss: 1.3290

```
Epoch 28/50
265/265 3s 7ms/step - accuracy: 0.5076 - loss: 1.6291 - val_accuracy: 0.5900 - val_loss: 1.3368
Epoch 29/50
265/265 1s 5ms/step - accuracy: 0.5069 - loss: 1.6085 - val_accuracy: 0.5980 - val_loss: 1.3389
Epoch 30/50
265/265 3s 5ms/step - accuracy: 0.5071 - loss: 1.6173 - val_accuracy: 0.5900 - val_loss: 1.3230
Epoch 31/50
265/265 1s 5ms/step - accuracy: 0.5076 - loss: 1.5983 - val_accuracy: 0.5980 - val_loss: 1.3383
Epoch 32/50
265/265 3s 5ms/step - accuracy: 0.5127 - loss: 1.5987 - val_accuracy: 0.6010 - val_loss: 1.3029
Epoch 33/50
265/265 3s 7ms/step - accuracy: 0.5004 - loss: 1.6281 - val_accuracy: 0.5970 - val_loss: 1.2927
Epoch 34/50
265/265 2s 8ms/step - accuracy: 0.5162 - loss: 1.5745 - val_accuracy: 0.6050 - val_loss: 1.2997
Epoch 35/50
265/265 2s 6ms/step - accuracy: 0.5025 - loss: 1.6087 - val_accuracy: 0.5920 - val_loss: 1.2884
Epoch 36/50
265/265 1s 5ms/step - accuracy: 0.5091 - loss: 1.6107 - val_accuracy: 0.5960 - val_loss: 1.3061
Epoch 37/50
265/265 1s 5ms/step - accuracy: 0.5222 - loss: 1.5857 - val_accuracy: 0.5970 - val_loss: 1.2941
Epoch 38/50
265/265 2s 6ms/step - accuracy: 0.5158 - loss: 1.5889 - val_accuracy: 0.6030 - val_loss: 1.2998
Epoch 39/50
265/265 1s 5ms/step - accuracy: 0.5225 - loss: 1.5752 - val_accuracy: 0.5880 - val_loss: 1.2917
Epoch 40/50
265/265 3s 5ms/step - accuracy: 0.5068 - loss: 1.5897 - val_accuracy: 0.6050 - val_loss: 1.2888
Epoch 41/50
265/265 2s 7ms/step - accuracy: 0.5168 - loss: 1.5768 - val_accuracy: 0.6010 - val_loss: 1.2974
Epoch 42/50
265/265 2s 9ms/step - accuracy: 0.5155 - loss: 1.5662 - val_accuracy: 0.6020 - val_loss: 1.2850
Epoch 43/50
265/265 1s 5ms/step - accuracy: 0.5209 - loss: 1.5639 - val_accuracy: 0.6000 - val_loss: 1.2840
Epoch 44/50
265/265 3s 5ms/step - accuracy: 0.5241 - loss: 1.5601 - val_accuracy: 0.5990 - val_loss: 1.2793
Epoch 45/50
265/265 3s 5ms/step - accuracy: 0.5221 - loss: 1.5610 - val_accuracy: 0.6040 - val_loss: 1.2690
Epoch 46/50
265/265 1s 5ms/step - accuracy: 0.5213 - loss: 1.5622 - val_accuracy: 0.6090 - val_loss: 1.2828
Epoch 47/50
265/265 1s 5ms/step - accuracy: 0.5139 - loss: 1.5793 - val_accuracy: 0.6040 - val_loss: 1.2760
Epoch 48/50
265/265 2s 7ms/step - accuracy: 0.5195 - loss: 1.5680 - val_accuracy: 0.6030 - val_loss: 1.2823
Epoch 49/50
265/265 3s 8ms/step - accuracy: 0.5204 - loss: 1.5667 - val_accuracy: 0.5930 - val_loss: 1.2598
Epoch 50/50
265/265 2s 5ms/step - accuracy: 0.5279 - loss: 1.5438 - val_accuracy: 0.6170 - val_loss: 1.2571
Accuracy: 0.5915
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_33"

Layer (type)	Output Shape	Param #
dense_186 (Dense)	(None, 32)	352
batch_normalization_153 (BatchNormalization)	(None, 32)	128
dropout_150 (Dropout)	(None, 32)	0
dense_187 (Dense)	(None, 64)	2,112
batch_normalization_154 (BatchNormalization)	(None, 64)	256
dropout_151 (Dropout)	(None, 64)	0
dense_188 (Dense)	(None, 128)	8,320
batch_normalization_155 (BatchNormalization)	(None, 128)	512
dropout_152 (Dropout)	(None, 128)	0
dense_189 (Dense)	(None, 64)	8,256
batch_normalization_156 (BatchNormalization)	(None, 64)	256
dropout_153 (Dropout)	(None, 64)	0
dense_190 (Dense)	(None, 32)	2,080
batch_normalization_157 (BatchNormalization)	(None, 32)	128
dense_191 (Dense)	(None, 16)	528
batch_normalization_158 (BatchNormalization)	(None, 16)	64
dropout_154 (Dropout)	(None, 16)	0
dense_192 (Dense)	(None, 8)	136
batch_normalization_159 (BatchNormalization)	(None, 8)	32
dropout_155 (Dropout)	(None, 8)	0
dense_193 (Dense)	(None, 16)	144
batch_normalization_160 (BatchNormalization)	(None, 16)	64
dropout_156 (Dropout)	(None, 16)	0

dense_194 (Dense)	(None, 32)	544
batch_normalization_161 (BatchNormalization)	(None, 32)	128
dropout_157 (Dropout)	(None, 32)	0
dense_195 (Dense)	(None, 20)	660

Total params: 24,700 (96.48 KB)

Trainable params: 23,916 (93.42 KB)

Non-trainable params: 784 (3.06 KB)

None
Model compiled.
Epoch 1/50
265/265 9s 9ms/step - accuracy: 0.0654 - loss: 3.6842 - val_accuracy: 0.2330 - val_loss: 2.8401
Epoch 2/50
265/265 2s 8ms/step - accuracy: 0.1357 - loss: 2.9722 - val_accuracy: 0.3030 - val_loss: 2.3648
Epoch 3/50
265/265 2s 5ms/step - accuracy: 0.1888 - loss: 2.6483 - val_accuracy: 0.3310 - val_loss: 2.2186
Epoch 4/50
265/265 1s 5ms/step - accuracy: 0.2266 - loss: 2.5008 - val_accuracy: 0.3730 - val_loss: 2.1142
Epoch 5/50
265/265 3s 5ms/step - accuracy: 0.2522 - loss: 2.4020 - val_accuracy: 0.3770 - val_loss: 2.0370
Epoch 6/50
265/265 3s 6ms/step - accuracy: 0.2746 - loss: 2.3296 - val_accuracy: 0.3830 - val_loss: 1.9656
Epoch 7/50
265/265 1s 5ms/step - accuracy: 0.2839 - loss: 2.2631 - val_accuracy: 0.4040 - val_loss: 1.9207
Epoch 8/50
265/265 2s 7ms/step - accuracy: 0.3028 - loss: 2.2033 - val_accuracy: 0.4140 - val_loss: 1.8665
Epoch 9/50
265/265 2s 8ms/step - accuracy: 0.3086 - loss: 2.1675 - val_accuracy: 0.4270 - val_loss: 1.8373
Epoch 10/50
265/265 1s 5ms/step - accuracy: 0.3164 - loss: 2.1328 - val_accuracy: 0.4370 - val_loss: 1.8022
Epoch 11/50
265/265 2s 5ms/step - accuracy: 0.3187 - loss: 2.1192 - val_accuracy: 0.4510 - val_loss: 1.7789
Epoch 12/50
265/265 3s 6ms/step - accuracy: 0.3253 - loss: 2.0856 - val_accuracy: 0.4520 - val_loss: 1.7632
Epoch 13/50
265/265 2s 5ms/step - accuracy: 0.3289 - loss: 2.0785 - val_accuracy: 0.4540 - val_loss: 1.7368
Epoch 14/50
265/265 2s 6ms/step - accuracy: 0.3365 - loss: 2.0616 - val_accuracy: 0.4540 - val_loss: 1.7317
Epoch 15/50
265/265 3s 8ms/step - accuracy: 0.3504 - loss: 2.0281 - val_accuracy: 0.4620 - val_loss: 1.6992
Epoch 16/50
265/265 1s 5ms/step - accuracy: 0.3430 - loss: 2.0281 - val_accuracy: 0.4880 - val_loss: 1.6798
Epoch 17/50
265/265 1s 5ms/step - accuracy: 0.3479 - loss: 2.0228 - val_accuracy: 0.4810 - val_loss: 1.6636
Epoch 18/50
265/265 1s 5ms/step - accuracy: 0.3496 - loss: 2.0091 - val_accuracy: 0.4740 - val_loss: 1.6453
Epoch 19/50
265/265 3s 5ms/step - accuracy: 0.3603 - loss: 1.9954 - val_accuracy: 0.4990 - val_loss: 1.6369
Epoch 20/50
265/265 3s 5ms/step - accuracy: 0.3682 - loss: 1.9816 - val_accuracy: 0.4780 - val_loss: 1.6354
Epoch 21/50
265/265 2s 6ms/step - accuracy: 0.3665 - loss: 1.9814 - val_accuracy: 0.4960 - val_loss: 1.6107
Epoch 22/50
265/265 2s 8ms/step - accuracy: 0.3690 - loss: 1.9655 - val_accuracy: 0.5010 - val_loss: 1.6013
Epoch 23/50
265/265 2s 7ms/step - accuracy: 0.3632 - loss: 1.9751 - val_accuracy: 0.4900 - val_loss: 1.5917
Epoch 24/50
265/265 2s 5ms/step - accuracy: 0.3895 - loss: 1.9210 - val_accuracy: 0.5020 - val_loss: 1.5903
Epoch 25/50
265/265 1s 5ms/step - accuracy: 0.3844 - loss: 1.9467 - val_accuracy: 0.5110 - val_loss: 1.5833
Epoch 26/50
265/265 1s 5ms/step - accuracy: 0.3987 - loss: 1.9220 - val_accuracy: 0.5130 - val_loss: 1.5562
Epoch 27/50
265/265 1s 5ms/step - accuracy: 0.3812 - loss: 1.9307 - val_accuracy: 0.5150 - val_loss: 1.5572

```
Epoch 28/50
265/265 3s 5ms/step - accuracy: 0.3899 - loss: 1.9235 - val_accuracy: 0.5310 - val_loss: 1.5506
Epoch 29/50
265/265 2s 8ms/step - accuracy: 0.3945 - loss: 1.9107 - val_accuracy: 0.5110 - val_loss: 1.5606
Epoch 30/50
265/265 2s 7ms/step - accuracy: 0.3886 - loss: 1.9188 - val_accuracy: 0.5220 - val_loss: 1.5406
Epoch 31/50
265/265 2s 5ms/step - accuracy: 0.4045 - loss: 1.8780 - val_accuracy: 0.5150 - val_loss: 1.5293
Epoch 32/50
265/265 1s 5ms/step - accuracy: 0.4048 - loss: 1.8879 - val_accuracy: 0.5280 - val_loss: 1.5239
Epoch 33/50
265/265 3s 5ms/step - accuracy: 0.4044 - loss: 1.8891 - val_accuracy: 0.5430 - val_loss: 1.5025
Epoch 34/50
265/265 1s 5ms/step - accuracy: 0.4051 - loss: 1.8680 - val_accuracy: 0.5370 - val_loss: 1.5024
Epoch 35/50
265/265 3s 6ms/step - accuracy: 0.4019 - loss: 1.8912 - val_accuracy: 0.5250 - val_loss: 1.4957
Epoch 36/50
265/265 3s 8ms/step - accuracy: 0.4080 - loss: 1.8723 - val_accuracy: 0.5350 - val_loss: 1.4835
Epoch 37/50
265/265 2s 5ms/step - accuracy: 0.4075 - loss: 1.8783 - val_accuracy: 0.5310 - val_loss: 1.4963
Epoch 38/50
265/265 3s 5ms/step - accuracy: 0.4143 - loss: 1.8525 - val_accuracy: 0.5360 - val_loss: 1.4764
Epoch 39/50
265/265 3s 5ms/step - accuracy: 0.4142 - loss: 1.8622 - val_accuracy: 0.5430 - val_loss: 1.4654
Epoch 40/50
265/265 1s 5ms/step - accuracy: 0.4163 - loss: 1.8589 - val_accuracy: 0.5320 - val_loss: 1.4784
Epoch 41/50
265/265 3s 7ms/step - accuracy: 0.4164 - loss: 1.8481 - val_accuracy: 0.5390 - val_loss: 1.4772
Epoch 42/50
265/265 2s 8ms/step - accuracy: 0.4132 - loss: 1.8464 - val_accuracy: 0.5570 - val_loss: 1.4517
Epoch 43/50
265/265 2s 7ms/step - accuracy: 0.4213 - loss: 1.8432 - val_accuracy: 0.5570 - val_loss: 1.4550
Epoch 44/50
265/265 1s 5ms/step - accuracy: 0.4242 - loss: 1.8436 - val_accuracy: 0.5470 - val_loss: 1.4648
Epoch 45/50
265/265 3s 5ms/step - accuracy: 0.4252 - loss: 1.8384 - val_accuracy: 0.5540 - val_loss: 1.4562
Epoch 46/50
265/265 3s 5ms/step - accuracy: 0.4364 - loss: 1.8115 - val_accuracy: 0.5530 - val_loss: 1.4542
Epoch 47/50
265/265 1s 5ms/step - accuracy: 0.4189 - loss: 1.8417 - val_accuracy: 0.5630 - val_loss: 1.4220
Epoch 48/50
265/265 2s 6ms/step - accuracy: 0.4226 - loss: 1.8132 - val_accuracy: 0.5460 - val_loss: 1.4482
Epoch 49/50
265/265 2s 8ms/step - accuracy: 0.4224 - loss: 1.8388 - val_accuracy: 0.5570 - val_loss: 1.4315
Epoch 50/50
265/265 2s 7ms/step - accuracy: 0.4316 - loss: 1.8190 - val_accuracy: 0.5720 - val_loss: 1.4126
Accuracy: 0.5745
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/dense.py:87: UserWarning:
```

```
Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/optimizers/base_optimizer.py:33: UserWarning:
```

```
Argument `decay` is no longer supported and will be ignored.
```

Model: "sequential_34"

Layer (type)	Output Shape	Param #
dense_196 (Dense)	(None, 32)	352
batch_normalization_162 (BatchNormalization)	(None, 32)	128
dropout_158 (Dropout)	(None, 32)	0
dense_197 (Dense)	(None, 64)	2,112
batch_normalization_163 (BatchNormalization)	(None, 64)	256
dropout_159 (Dropout)	(None, 64)	0
dense_198 (Dense)	(None, 128)	8,320
batch_normalization_164 (BatchNormalization)	(None, 128)	512
dropout_160 (Dropout)	(None, 128)	0
dense_199 (Dense)	(None, 64)	8,256
batch_normalization_165 (BatchNormalization)	(None, 64)	256
dropout_161 (Dropout)	(None, 64)	0
dense_200 (Dense)	(None, 32)	2,080
batch_normalization_166 (BatchNormalization)	(None, 32)	128
dense_201 (Dense)	(None, 16)	528
batch_normalization_167 (BatchNormalization)	(None, 16)	64
dropout_162 (Dropout)	(None, 16)	0
dense_202 (Dense)	(None, 8)	136
batch_normalization_168 (BatchNormalization)	(None, 8)	32
dropout_163 (Dropout)	(None, 8)	0
dense_203 (Dense)	(None, 16)	144
batch_normalization_169 (BatchNormalization)	(None, 16)	64
dropout_164 (Dropout)	(None, 16)	0

dense_204 (Dense)	(None, 32)	544
batch_normalization_170 (BatchNormalization)	(None, 32)	128
dropout_165 (Dropout)	(None, 32)	0
dense_205 (Dense)	(None, 20)	660

Total params: 24,700 (96.48 KB)

Trainable params: 23,916 (93.42 KB)

Non-trainable params: 784 (3.06 KB)

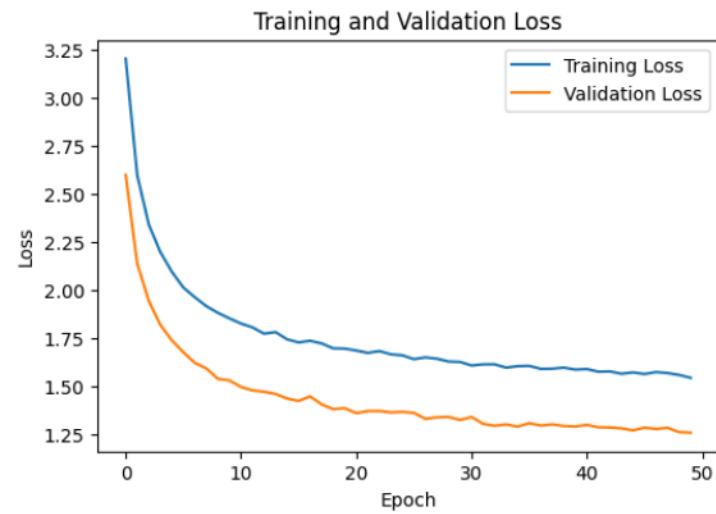
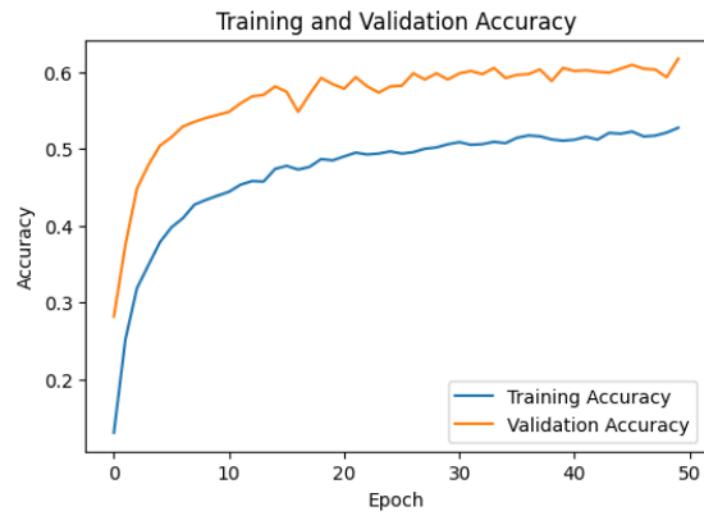
None
Model compiled.
Epoch 1/50
530/530 11s 8ms/step - accuracy: 0.2013 - loss: 2.7465 - val_accuracy: 0.3530 - val_loss: 2.0509
Epoch 2/50
530/530 4s 5ms/step - accuracy: 0.3146 - loss: 2.1717 - val_accuracy: 0.4330 - val_loss: 1.8810
Epoch 3/50
530/530 3s 5ms/step - accuracy: 0.3406 - loss: 2.1291 - val_accuracy: 0.4170 - val_loss: 1.9342
Epoch 4/50
530/530 3s 5ms/step - accuracy: 0.3554 - loss: 2.0884 - val_accuracy: 0.4490 - val_loss: 1.8282
Epoch 5/50
530/530 5s 5ms/step - accuracy: 0.3755 - loss: 2.0469 - val_accuracy: 0.4710 - val_loss: 1.7539
Epoch 6/50
530/530 3s 5ms/step - accuracy: 0.3789 - loss: 2.0443 - val_accuracy: 0.4730 - val_loss: 1.8405
Epoch 7/50
530/530 3s 5ms/step - accuracy: 0.3925 - loss: 2.0220 - val_accuracy: 0.4470 - val_loss: 1.7660
Epoch 8/50
530/530 3s 6ms/step - accuracy: 0.3989 - loss: 1.9941 - val_accuracy: 0.4860 - val_loss: 1.6912
Epoch 9/50
530/530 5s 5ms/step - accuracy: 0.4085 - loss: 2.0020 - val_accuracy: 0.4770 - val_loss: 1.7349
Epoch 10/50
530/530 3s 5ms/step - accuracy: 0.4041 - loss: 1.9768 - val_accuracy: 0.4760 - val_loss: 1.7736
Epoch 11/50
530/530 6s 7ms/step - accuracy: 0.3955 - loss: 1.9996 - val_accuracy: 0.4770 - val_loss: 1.7291
Epoch 12/50
530/530 4s 5ms/step - accuracy: 0.4072 - loss: 1.9773 - val_accuracy: 0.4810 - val_loss: 1.6779
Epoch 13/50
530/530 3s 5ms/step - accuracy: 0.4136 - loss: 1.9704 - val_accuracy: 0.4570 - val_loss: 1.8247
Epoch 14/50
530/530 3s 5ms/step - accuracy: 0.4198 - loss: 1.9434 - val_accuracy: 0.4970 - val_loss: 1.6551
Epoch 15/50
530/530 4s 8ms/step - accuracy: 0.4256 - loss: 1.9246 - val_accuracy: 0.4960 - val_loss: 1.6963
Epoch 16/50
530/530 4s 5ms/step - accuracy: 0.4265 - loss: 1.9419 - val_accuracy: 0.4790 - val_loss: 1.7155
Epoch 17/50
530/530 5s 5ms/step - accuracy: 0.4255 - loss: 1.9272 - val_accuracy: 0.5010 - val_loss: 1.6808
Epoch 18/50
530/530 6s 7ms/step - accuracy: 0.4266 - loss: 1.9325 - val_accuracy: 0.4760 - val_loss: 1.7542
Epoch 19/50
530/530 3s 5ms/step - accuracy: 0.4249 - loss: 1.9322 - val_accuracy: 0.5340 - val_loss: 1.6195
Epoch 20/50
530/530 5s 5ms/step - accuracy: 0.4258 - loss: 1.9200 - val_accuracy: 0.5170 - val_loss: 1.6224
Epoch 21/50
530/530 6s 7ms/step - accuracy: 0.4329 - loss: 1.9096 - val_accuracy: 0.5370 - val_loss: 1.6397
Epoch 22/50
530/530 4s 5ms/step - accuracy: 0.4221 - loss: 1.9333 - val_accuracy: 0.5090 - val_loss: 1.6798
Epoch 23/50
530/530 6s 6ms/step - accuracy: 0.4416 - loss: 1.8949 - val_accuracy: 0.5190 - val_loss: 1.6842
Epoch 24/50
530/530 5s 5ms/step - accuracy: 0.4385 - loss: 1.9019 - val_accuracy: 0.5180 - val_loss: 1.6456
Epoch 25/50
530/530 5s 5ms/step - accuracy: 0.4392 - loss: 1.8919 - val_accuracy: 0.4990 - val_loss: 1.6642
Epoch 26/50
530/530 3s 6ms/step - accuracy: 0.4393 - loss: 1.8759 - val_accuracy: 0.5120 - val_loss: 1.6275
Epoch 27/50
530/530 4s 7ms/step - accuracy: 0.4398 - loss: 1.9010 - val_accuracy: 0.5570 - val_loss: 1.5594

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Epoch 28/50
530/530 4s 5ms/step - accuracy: 0.4543 - loss: 1.8880 - val_accuracy: 0.5360 - val_loss: 1.6269
Epoch 29/50
530/530 3s 5ms/step - accuracy: 0.4463 - loss: 1.8967 - val_accuracy: 0.4780 - val_loss: 1.7298
Epoch 30/50
530/530 6s 7ms/step - accuracy: 0.4465 - loss: 1.8751 - val_accuracy: 0.5040 - val_loss: 1.6558
Epoch 31/50
530/530 3s 5ms/step - accuracy: 0.4419 - loss: 1.8875 - val_accuracy: 0.5060 - val_loss: 1.6449
Epoch 32/50
530/530 5s 5ms/step - accuracy: 0.4489 - loss: 1.8682 - val_accuracy: 0.5390 - val_loss: 1.5921
Epoch 33/50
530/530 6s 7ms/step - accuracy: 0.4487 - loss: 1.8873 - val_accuracy: 0.5590 - val_loss: 1.5362
Epoch 34/50
530/530 3s 5ms/step - accuracy: 0.4517 - loss: 1.8568 - val_accuracy: 0.5060 - val_loss: 1.6511
Epoch 35/50
530/530 5s 5ms/step - accuracy: 0.4386 - loss: 1.8941 - val_accuracy: 0.5300 - val_loss: 1.6404
Epoch 36/50
530/530 4s 7ms/step - accuracy: 0.4472 - loss: 1.8844 - val_accuracy: 0.5310 - val_loss: 1.5783
Epoch 37/50
530/530 3s 6ms/step - accuracy: 0.4531 - loss: 1.8589 - val_accuracy: 0.5570 - val_loss: 1.5429
Epoch 38/50
530/530 3s 5ms/step - accuracy: 0.4639 - loss: 1.8632 - val_accuracy: 0.5190 - val_loss: 1.6559
Epoch 39/50
530/530 5s 6ms/step - accuracy: 0.4491 - loss: 1.8719 - val_accuracy: 0.5510 - val_loss: 1.5815
Epoch 40/50
530/530 5s 6ms/step - accuracy: 0.4463 - loss: 1.8931 - val_accuracy: 0.5110 - val_loss: 1.6564
Epoch 41/50
530/530 3s 5ms/step - accuracy: 0.4532 - loss: 1.8581 - val_accuracy: 0.5410 - val_loss: 1.5864
Epoch 42/50
530/530 6s 6ms/step - accuracy: 0.4482 - loss: 1.8718 - val_accuracy: 0.5370 - val_loss: 1.6099
Epoch 43/50
530/530 4s 7ms/step - accuracy: 0.4605 - loss: 1.8644 - val_accuracy: 0.5270 - val_loss: 1.6306
Epoch 44/50
530/530 4s 5ms/step - accuracy: 0.4669 - loss: 1.8444 - val_accuracy: 0.5390 - val_loss: 1.5459
Epoch 45/50
530/530 3s 6ms/step - accuracy: 0.4611 - loss: 1.8574 - val_accuracy: 0.5340 - val_loss: 1.5567
Epoch 46/50
530/530 3s 6ms/step - accuracy: 0.4531 - loss: 1.8693 - val_accuracy: 0.5520 - val_loss: 1.5446
Epoch 47/50
```

```
In [ ]: plt.figure(figsize=(6, 4))
plt.plot(best_history.history['accuracy'], label='Training Accuracy')
plt.plot(best_history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Training and Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

plt.figure(figsize=(6, 4))
plt.plot(best_history.history['loss'], label='Training Loss')
plt.plot(best_history.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
```

```
plt.legend()  
plt.show()
```



```
In [ ]: best_model.evaluate(X_test, y_test)  
63/63 ━━━━━━━━ 0s 3ms/step - accuracy: 0.5909 - loss: 1.3261
```

```
out[ ]: [1.3242542743682861, 0.5914999842643738]
```