# Task-3 Convolutional Neural Network(CNN) For Image Recognition

## Importing Libraries

In [4]:

```
import numpy as np
import tensorflow as tf
from tensorflow.keras import layers, models
from tensorflow.keras.utils import to_categorical
from sklearn.metrics import confusion_matrix, classification_report
import matplotlib.pyplot as plt
import seaborn as sns
```

## Loading & Preprocessing Dataset

In [5]:

```
(X_train, y_train), (X_test, y_test) = tf.keras.datasets.cifar10.load_data()

X_train, X_test = X_train / 255.0, X_test / 255.0

y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)
```

## CNN Model

In [6]:

```
model = models.Sequential()

model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(32, 32, 3)))
model.add(layers.MaxPooling2D((2, 2)))

model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.MaxPooling2D((2, 2)))

model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.MaxPooling2D((2, 2)))

model.add(layers.Flatten())
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dense(10, activation='softmax'))

model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
```

# Model Training

In [7]:

```
history = model.fit(X_train, y_train, epochs=10, validation_data=(X_test, y_test))
```

```
Epoch 1/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 35s 20ms/step - accuracy: 0.3265 - loss: 1.8117 - val_accuracy: 0.5110 - val_loss: 1.379
1
Epoch 2/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 29s 18ms/step - accuracy: 0.5395 - loss: 1.2865 - val_accuracy: 0.5675 - val_loss: 1.226
9
Epoch 3/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 29s 18ms/step - accuracy: 0.6016 - loss: 1.1260 - val_accuracy: 0.6077 - val_loss: 1.128
0
Epoch 4/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 29s 19ms/step - accuracy: 0.6404 - loss: 1.0272 - val_accuracy: 0.6421 - val_loss: 1.022
6
Epoch 5/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 28s 18ms/step - accuracy: 0.6690 - loss: 0.9480 - val_accuracy: 0.6444 - val_loss: 1.038
3
Epoch 6/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 30s 19ms/step - accuracy: 0.6842 - loss: 0.9022 - val_accuracy: 0.6719 - val_loss: 0.962
6
Epoch 7/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 30s 19ms/step - accuracy: 0.7047 - loss: 0.8430 - val_accuracy: 0.6740 - val_loss: 0.936
4
Epoch 8/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 30s 19ms/step - accuracy: 0.7156 - loss: 0.8079 - val_accuracy: 0.6711 - val_loss: 0.959
8
Epoch 9/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 31s 20ms/step - accuracy: 0.7270 - loss: 0.7758 - val_accuracy: 0.6789 - val_loss: 0.943
1
Epoch 10/10
1563/1563 ━━━━━━━━━━━━━━━━━━━━ 29s 19ms/step - accuracy: 0.7384 - loss: 0.7459 - val_accuracy: 0.6999 - val_loss: 0.896
8
```

# Model Evaluation

```
In [8]: test_loss, test_acc = model.evaluate(X_test, y_test)
        print(f"Test accuracy: {test_acc:.4f}")
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step - accuracy: 0.7072 - loss: 0.8826
Test accuracy: 0.6999
```

# Computing Confusion Matrix

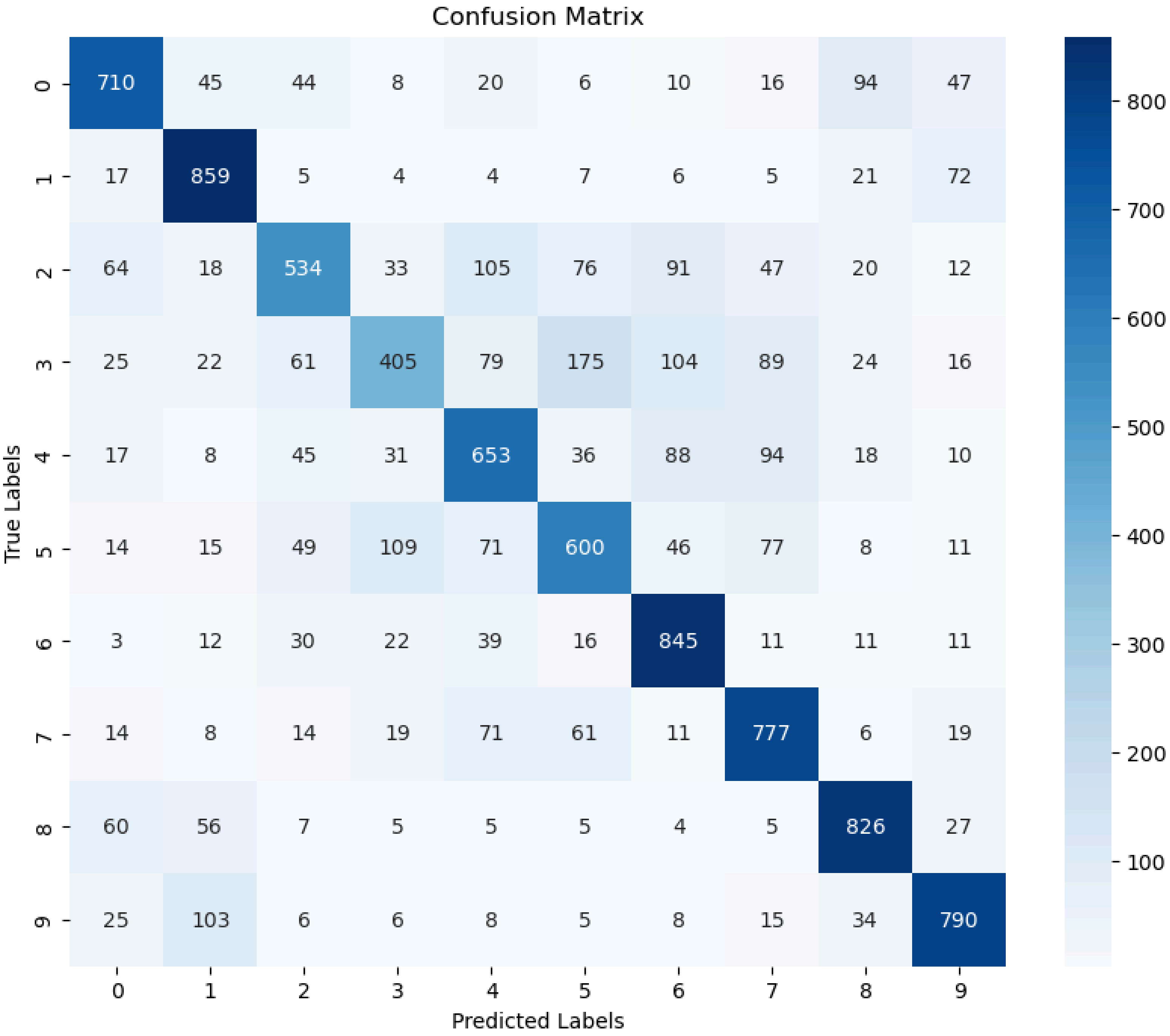
```
In [9]: y_pred = model.predict(X_test)
        y_pred_classes = np.argmax(y_pred, axis=1)
        y_true = np.argmax(y_test, axis=1)

        conf_matrix = confusion_matrix(y_true, y_pred_classes)
        plt.figure(figsize=(10, 8))
        sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', xticklabels=range(10), yticklabels=range(10))
        plt.xlabel('Predicted Labels')
        plt.ylabel('True Labels')
        plt.title('Confusion Matrix')
        plt.show()

        print("\nClassification Report:\n", classification_report(y_true, y_pred_classes, target_names=[
            'airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship', 'truck']))

        model.save('cnn_cifar10_model.h5')
```

```
313/313 ━━━━━━━━━━━━━━━━━━━━ 3s 9ms/step
```



Confusion Matrix

|  | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 710 | 45 | 44 | 8 | 20 | 6 | 10 | 16 | 94 | 47 |
| 1 | 17 | 859 | 5 | 4 | 4 | 7 | 6 | 5 | 21 | 72 |
| 2 | 64 | 18 | 534 | 33 | 105 | 76 | 91 | 47 | 20 | 12 |
| 3 | 25 | 22 | 61 | 405 | 79 | 175 | 104 | 89 | 24 | 16 |
| 4 | 17 | 8 | 45 | 31 | 653 | 36 | 88 | 94 | 18 | 10 |
| 5 | 14 | 15 | 49 | 109 | 71 | 600 | 46 | 77 | 8 | 11 |
| 6 | 3 | 12 | 30 | 22 | 39 | 16 | 845 | 11 | 11 | 11 |
| 7 | 14 | 8 | 14 | 19 | 71 | 61 | 11 | 777 | 6 | 19 |
| 8 | 60 | 56 | 7 | 5 | 5 | 5 | 4 | 5 | 826 | 27 |
| 9 | 25 | 103 | 6 | 6 | 8 | 5 | 8 | 15 | 34 | 790 |

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This fil
e format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')`
or `keras.saving.save_model(model, 'my_model.keras')`.
Classification Report:
              precision    recall  f1-score   support

    airplane       0.75      0.71      0.73      1000
  automobile       0.75      0.86      0.80      1000
        bird       0.67      0.53      0.59      1000
         cat       0.63      0.41      0.49      1000
        deer       0.62      0.65      0.64      1000
         dog       0.61      0.60      0.60      1000
        frog       0.70      0.84      0.76      1000
       horse       0.68      0.78      0.73      1000
        ship       0.78      0.83      0.80      1000
       truck       0.78      0.79      0.78      1000

    accuracy                           0.70     10000
   macro avg       0.70      0.70      0.69     10000
weighted avg       0.70      0.70      0.69     10000
```