The goal of this task was to apply **image augmentation techniques** to improve the **generalization and accuracy** of a CNN model for image classification using the **CIFAR-10 dataset**.

## 2. Dataset

- **CIFAR-10 dataset**
  - 60,000 images (32×32 pixels), 10 classes.
  - 50,000 training images, 10,000 test images.
- **Preprocessing:**
  - Pixel values normalized to [0,1]
  - Labels converted to one-hot vectors

## 3. Data Augmentation Pipeline

- Implemented using **Image Data Generator** in TensorFlow/Keras.
- Augmentation techniques applied:
  - Rotation (±20°)
  - Width & Height Shifts (±20%)
  - Shear (0.2)
  - Zoom (0.2)
  - Horizontal Flip
  - Brightness Adjustment (0.8 – 1.2)
- **Baseline dataset** used no augmentation (Image Data Generator() only).
- Sample augmented images were visualized to verify correctness.

## 4. CNN Model Architecture

- Sequential CNN:
  1. Conv2D (32 filters, 3×3) + ReLU → MaxPooling2D

2. Conv2D (64 filters, 3×3) + ReLU → MaxPooling2D

3. Conv2D (128 filters, 3×3) + ReLU

4. Flatten → Dense(128) + ReLU → Dropout(0.5) → Dense(10) + Softmax

- **Optimizer:** Adam

- **Loss:** Categorical Cross entropy

- **Metrics:** Accuracy

## 5. Training

- **Baseline CNN (No Augmentation):**

  o Trained on original images for 20 epochs, batch size 64

  o Model saved as: baseline_cnn.h5

- **CNN with Augmentation:**

  o Trained on augmented images for 20 epochs, batch size 64

  o Model saved as: augmented_cnn.h5

## 6. Evaluation & Results

Test Set Evaluation (from Colab output):

| Model | Test Accuracy | Test Loss |
|---|---|---|
| Baseline CNN | 0.7123 | 0.8231 |
| Augmented CNN | 0.7550 | 0.6987 |

- 
  Accuracy and loss curves show that the augmented CNN converges more smoothly.

- Baseline CNN shows slight overfitting, while augmented CNN generalizes better.


## 7. Insights & Conclusion

- **Data augmentation** improves generalization and stability of the CNN model on unseen data.

- Augmented CNN achieves **higher test accuracy** and **lower test loss** than the baseline CNN.

- Training with augmented data reduces overfitting.

- Applying rotations, shifts, flips, zoom, and brightness adjustment is effective for small image datasets like CIFAR-10.

- Overall, **augmentation leads to a more robust and reliable model** for image classification tasks.


## 8. Deliverables

1. **Models:**
   - baseline_cnn.h5
   - augmented_cnn.h5

2. **Plots:** Training/validation accuracy & loss curves, augmented image samples

3. **Report:** This summary