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):**
  + Trained on original images for 20 epochs, batch size 64
  + Model saved as: baseline\_cnn.h5
* **CNN with Augmentation:**
  + Trained on augmented images for 20 epochs, batch size 64
  + 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