



# Image classification on CIFAR-10 dataset

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**Shashwat N Singh**

IIT Madras Zanzibar

Data Science & AI

M.Tech/012

**Github Link**

[CIFAR-10-Image-Classification/CIFAR\\_10\\_Image\\_Classification.ipynb at main · shashwatns/CIFAR-10-Image-Classification \(github.com\)](https://github.com/shashwatns/CIFAR-10-Image-Classification)

## **Imported Libraries:**

**-Machine Learning and Data Visualization:** Introduced libraries for various tasks, including TensorFlow for neural networks and deep learning, Keras for accessing the CIFAR-10 dataset, Matplotlib for visualization, and scikit-learn for data preprocessing, model selection, and evaluation.

**-Algorithms and Metrics:** Included machine learning algorithms such as Random Forest Classifier, Decision Tree Classifier, Gaussian Naive Bayes and KNN. Evaluation metrics like accuracy, precision, recall, F1 score, and the confusion matrix were also imported from scikit-learn.

## **CIFAR-10 Dataset Preparation:**

- Utilized TensorFlow to load the CIFAR-10 dataset, splitting it into training (x\_train, y\_train) and testing (x\_test, y\_test) sets, where `x` contains images and `y` contains labels.
- Normalized image pixel values in both sets to a 0-1 range by dividing by 255.0, and reshaped images into a one-dimensional array.

## **Model Fitting and evaluation:**

- Fitted the machine learning algorithms such as Random Forest Classifier, Decision Tree Classifier, Gaussian Naive Bayes and KNN on training image dataset. With varying validation sets:

## **Colour Images**

### **a) No Validation set-**

Decision Tree:

Accuracy: 0.2723

Precision: 0.27206949810244596

Recall: 0.27230000000000004

F1 Score: 0.27208160841130413

Random Forest:

Accuracy: 0.4662

Precision: 0.4618551099166755

Recall: 0.46620000000000006

F1 Score: 0.46250907886928944

Naive Bayes:

Accuracy: 0.2976

Precision: 0.3112140667418117

Recall: 0.29760000000000003

F1 Score: 0.2754627838655197

KNN (k=5):

Accuracy: 0.3398

Precision: 0.43042618255284965

Recall: 0.3398

F1 Score: 0.3260170986061005

**b) 1 validation set with 20% of 80%**

Decision Tree:

Validation Accuracy: 0.2536

Precision: 0.254755390586476

Recall: 0.25395039040503914

F1 Score: 0.25393721347395026

Random Forest:

Validation Accuracy: 0.4521

Precision: 0.4486845546749711

Recall: 0.4524598883269177

F1 Score: 0.4486604878154166

Naive Bayes:

Validation Accuracy: 0.2838

Precision: 0.2903552952819297

Recall: 0.285409963713768

F1 Score: 0.26119568442768293

KNN (k=5):

Validation Accuracy: 0.3325

Precision: 0.42660943408366936

Recall: 0.33427759981985805

F1 Score: 0.3186776412486527

**c) 3-fold cross validation set**

Decision Tree Cross-Validation Results:

Average Accuracy: 0.26150004061001225

Average Precision: 0.2619909622809072

Average Recall: 0.2615009051010926

Average F1 Score: 0.2615952652793825

Random Forest Cross-Validation Results:

Average Accuracy: 0.45249998756175125

Average Precision: 0.44951982046886957

Average Recall: 0.45250155251062624

Average F1 Score: 0.4493194339034135

Naive Bayes Cross-Validation Results:

Average Accuracy: 0.28438001622782855

Average Precision: 0.2952183617283109

Average Recall: 0.28438141903432035

Average F1 Score: 0.263002118273418

KNN (k=5) Cross-Validation Results:

Average Accuracy: 0.3254800114606132

Average Precision: 0.41694301642700715

Average Recall: 0.3254793579099306

Average F1 Score: 0.3104843457043133

**d) 5-fold cross validation set**

Decision Tree Cross-Validation Results:

Average Accuracy: 0.25992

Average Precision: 0.26053373984036277

Average Recall: 0.25992

Average F1 Score: 0.2601089120528405

Random Forest Cross-Validation Results:

Average Accuracy: 0.45822

Average Precision: 0.4545897189280093

Average Recall: 0.45822

Average F1 Score: 0.45475816975263983

Naive Bayes Cross-Validation Results:

Average Accuracy: 0.28480000000000005

Average Precision: 0.2955955084470586

Average Recall: 0.28480000000000005

Average F1 Score: 0.2633039374765517

KNN (k=5) Cross-Validation Results:

Average Accuracy: 0.3327

Average Precision: 0.42636486152381925

Average Recall: 0.33270000000000005

Average F1 Score: 0.31852543093801977

**e) 10-fold cross validation set**

Decision Tree Cross-Validation Results:

Average Accuracy: 0.2632

Average Precision: 0.2640633926145054

Average Recall: 0.2632



Average F1 Score: 0.2634717785954668

Random Forest Cross-Validation Results:

Average Accuracy: 0.46018

Average Precision: 0.4569187638280061

Average Recall: 0.46018

Average F1 Score: 0.4568362214099168

Naive Bayes Cross-Validation Results:

Average Accuracy: 0.28447999999999996

Average Precision: 0.294711544502295

Average Recall: 0.28448

Average F1 Score: 0.2628604439425539

KNN (k=5) Cross-Validation Results:

Average Accuracy: 0.33602

Average Precision: 0.42893888417254233

Average Recall: 0.33602

Average F1 Score: 0.3223506850986591

## **GrayScale Images**

- Then we converted the images to grayscale and applied the best performing model out of the ones chosen i.e, Random Forest Classifier

### **a) No Validation set-**

Random Forest Performance on Test Set:

Test Accuracy: 0.415

Precision: 0.4112983515025449

Recall: 0.41500000000000004

F1 Score: 0.41187880278306704

**b) 1 validation set with 20% of 80%**

Random Forest Performance on Test Set:

Test Accuracy: 0.4077

Precision: 0.4044064631671403

Recall: 0.4077

F1 Score: 0.4045338265577635

**c) 3-fold cross validation set**

Random Forest 3-Fold Cross-Validation Results:

Accuracy: 0.40378

Precision: 0.40086092619860364

Recall: 0.40378

F1 Score: 0.40076899942059124

**d) 5-fold cross validation set**

Random Forest 5-Fold Cross-Validation Results:

Accuracy: 0.4095

Precision: 0.4068063770895235

Recall: 0.4095

F1 Score: 0.40672777203749344

**e) 10-fold cross validation set**

Random Forest 10-Fold Cross-Validation Results:


Accuracy: 0.4116

Precision: 0.4087186651090041

Recall: 0.41159999999999997

F1 Score: 0.40874301684370007

**Performance Assessment:**



Conducted a detailed analysis of machine learning algorithms' performance on varying train-test- validation splits as summarized above, focusing on metrics like the confusion matrix, accuracy, precision, F1 score, and recall.

- Random Forest Classifier proved to give the best performance with 10 fold cross validation as expected
- Across all splits, precision, recall, and F1 scores offered deeper insights into algorithmic performance, underscoring the influence of train-test split choice on outcomes and the necessity for balanced datasets and careful metric selection for thorough model evaluation.