Parameter setting and reliability test of a sensor system for infant carrier car seat sensing in a car using a dashboard sensor

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Agenda

- Goal
- Research Questions.
- Experiment: ADC Data set collection, Programing Used, Confusion Matrix.
- MLP Models, Traing , Prediction.
- Comparison to CNN Model.
- Optimization of MLPs.
- Analysis and Research.
- Result.
- Conclusion.

Research Questions:

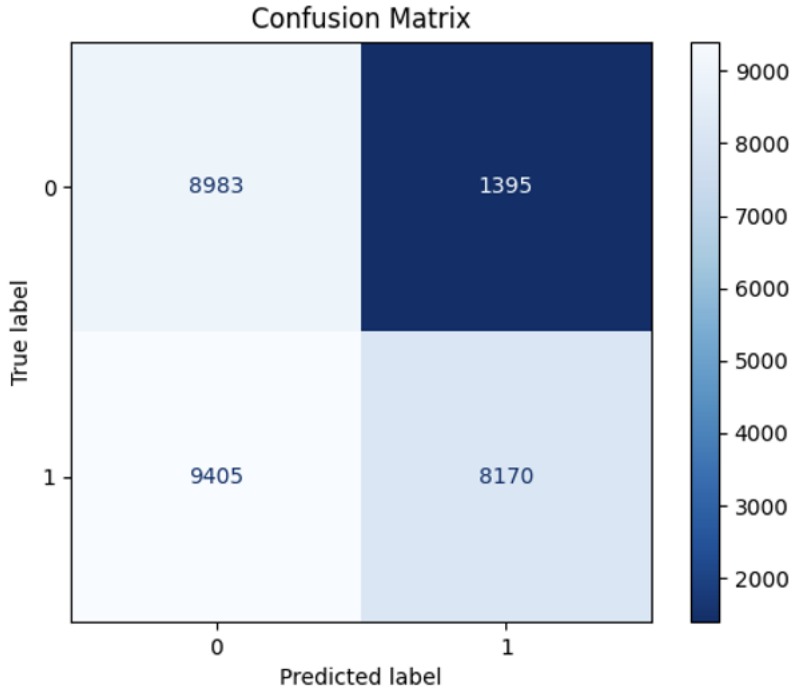
- How to validate the reliability of our Red Pitaya sensor prediction for baby doll presence ?
- How to fine tune any MLP or CNN , also how better can you use the experiment data sets to get better precision of the label prediction?

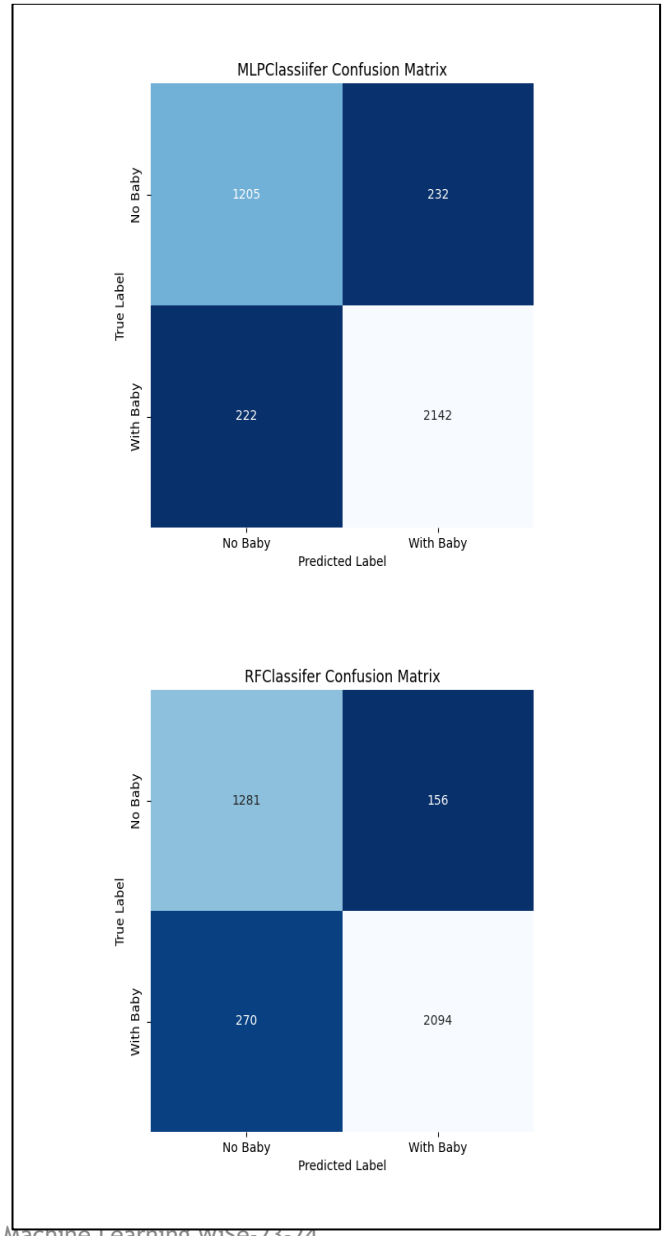
Experiment Setup:

- The Red Pitaya sensor is installed inside a car at the parking lot where the experiment is carried out
- We experimented on the sensor position or the distance of the baby doll from the sensor in the second variation, which included the seating posture.
- Multiple Data Sets collected and used for training the MLP of our choice: to verify the label prediction.
- Python Programing , PyCharm IDE , sklearn.metrics , keras.models.
- Random Forest, MLP Classifier
- Confusion Matrices, ROC Curve, Precision Recall curves plotted to compare and analyze the Accuracy and stability of the predictions.

Confusion Matrix on First Data set

- Data set 1 ADC to FFT conversion
- MLP Created
- DS1 splitted to traing and Test data.
- Confusion Matrix and various parameters like Accuracy and Precison , F1-score Observed

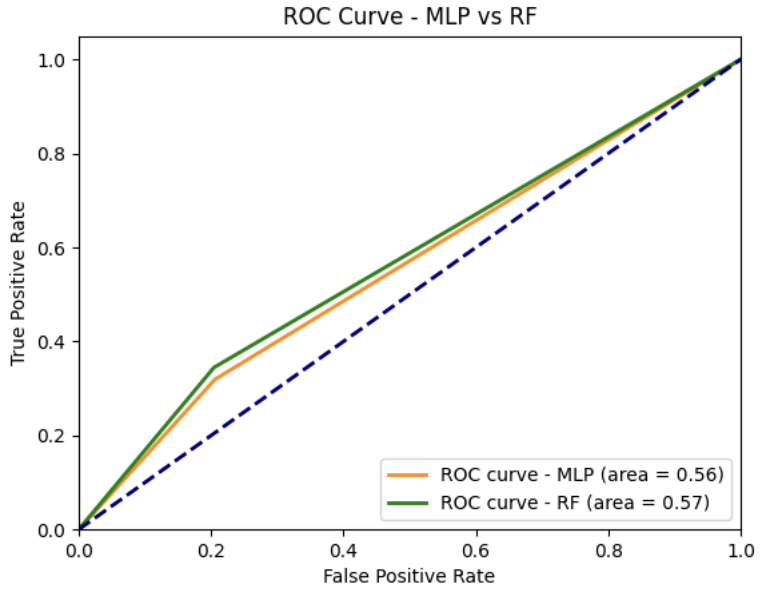


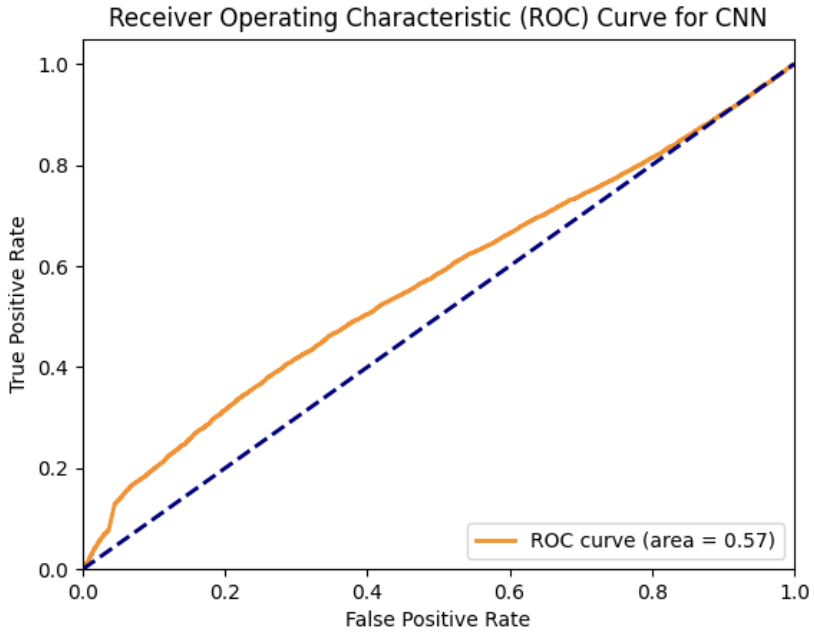


Compare Random Forest and MLP Classifier

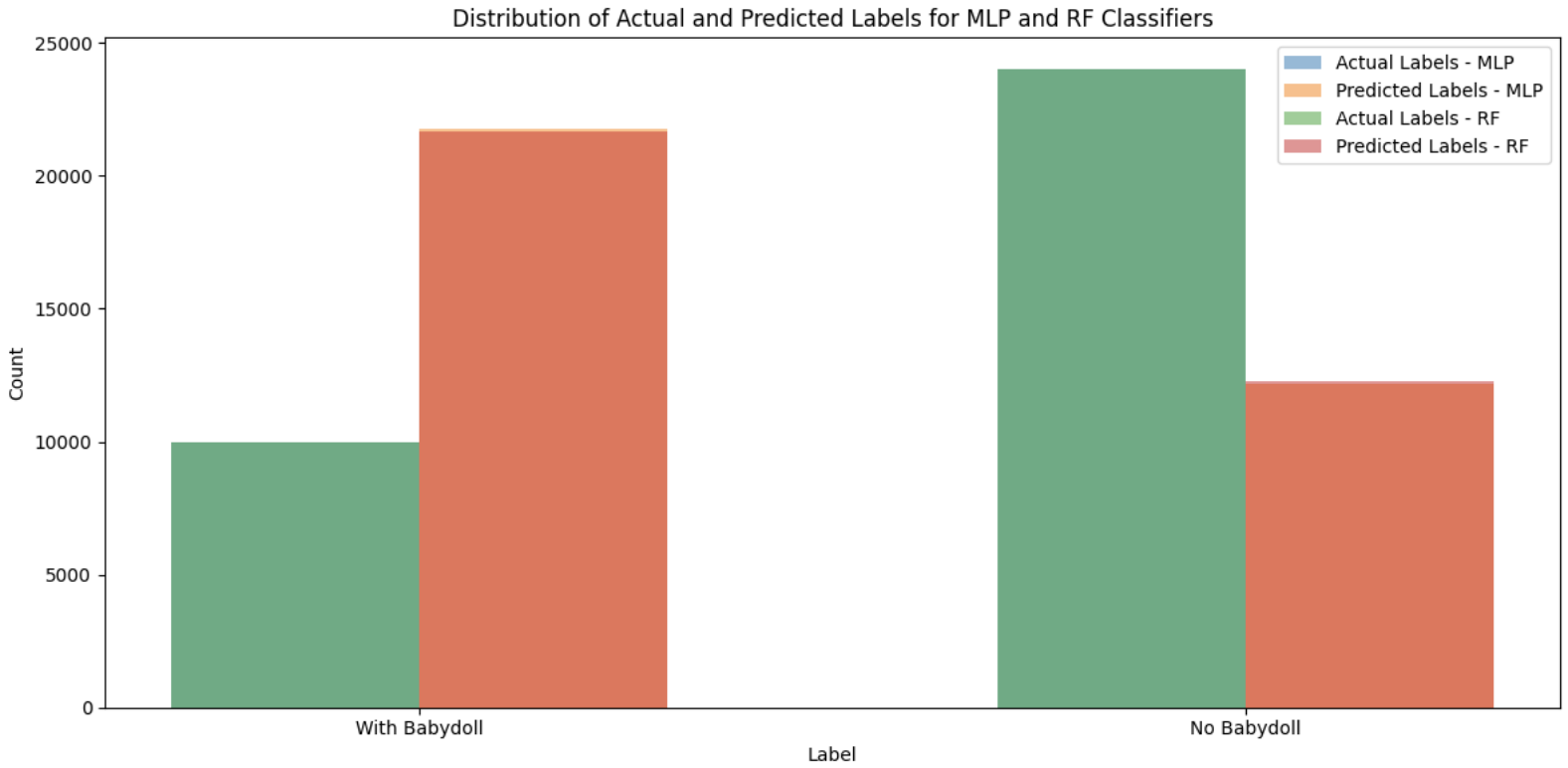
	Metric	RF Classifier	MLP Classifier
1.	Accuracy	0 .887924	0.888187
2.	Precision	0.930667	0.935730
3.	Recall	0.885787	0.880711
4.	F1 Score	0.907672	0.907387

Results and Analysis :



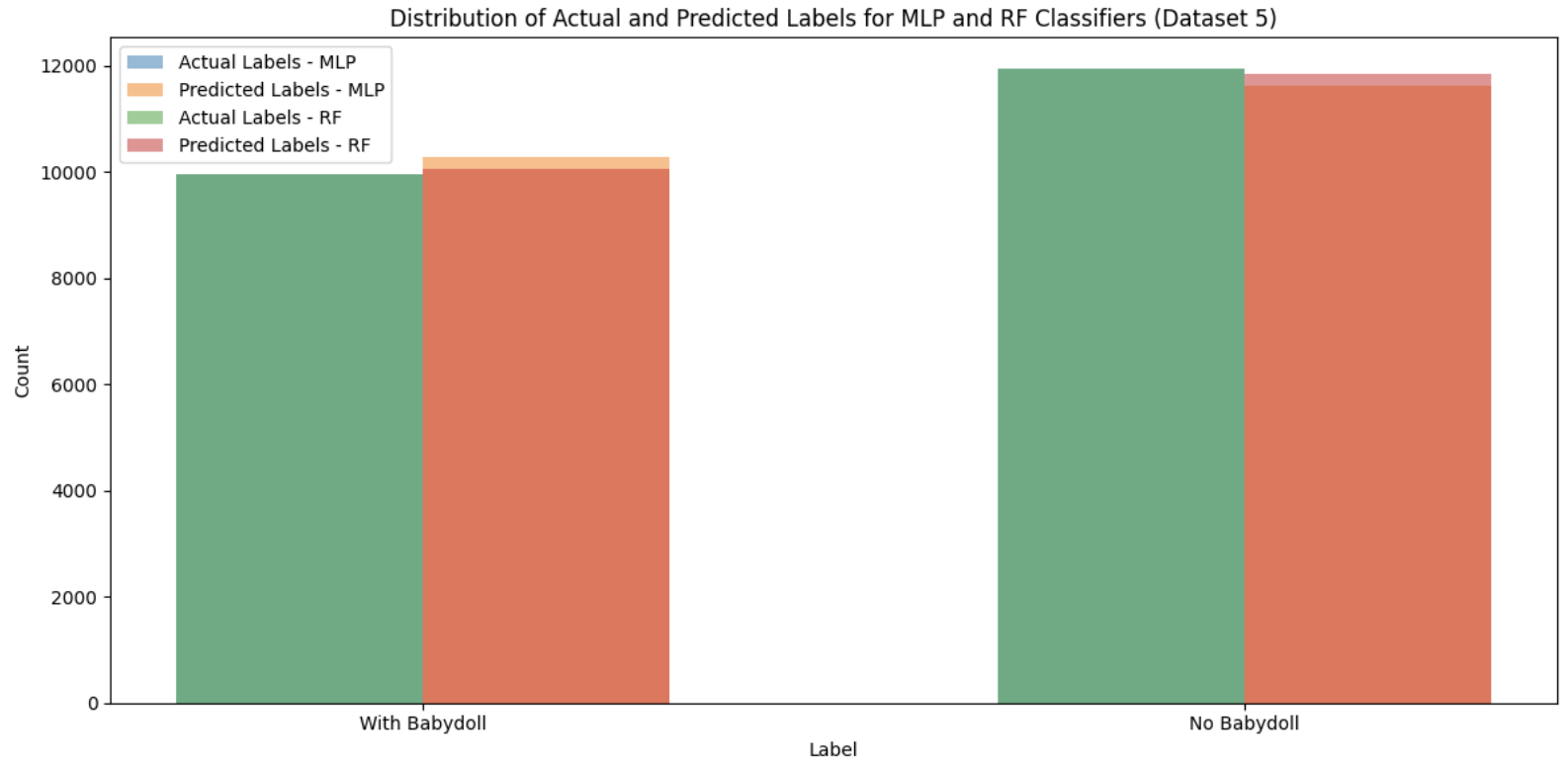


Label Prediction:



MLPClassifier Evaluation:	RandomForestClassifier Evaluation:
False Negative Rate: 0.5769166666666666 False Positive Rate: 0.20521564694082248 Cross-validation scores: [0.70650574 0.70650574 0.70650574 0.70650574 0.70650574] Mean CV score: 0.7065057403591404 Accuracy: 0.53 Precision: 0.83 Recall: 0.42 F1-score: 0.56	False Negative Rate: 0.5725833333333333 False Positive Rate: 0.2046138415245737 Cross-validation scores: [0.69634972 0.67692081 0.65911098 0.69561378 0.69443627] Mean CV score: 0.6844863114512806 Accuracy: 0.54 Precision: 0.83 Recall: 0.43 F1-score: 0.57

Label Prediction of Dataset 5:



Optimization of MLP, CNN

- Hyper Parameter adjustments
- Model Complexity
- Improved fit training of Model.
- Data set collection preprocessing (fft conversion, sampling rate)
- Keep track of Boundary Cases

Problem of Over fitting a model

- False predictions of the label were also observed.
- The reason :addition of unwanted experiment measurements (senor to baby carriage handle or sensor to baby head.)
- An overfitting of the model occurred.
  - The problem with the overfitting model of CNN and MLP is that it learns or memorize the training data instead of generalizing from it. This results in poor predictions on unknown dataset and scenarios.

Conclusion

- In our project, we have conducted experiments to verify and test parameters and also created a reliable, precise and accurate sensor system for infant carrier seat sensing in a car using a dashboard sensor (Red Pitaya).
- During the process, Confusion matrix, False negative and False positive rates were verified. With this, we have reached a plateau of 65-70 % accuracy and precision of label prediction.
- The F1-Score comparison with the tasks we have performed over the 3 different models are like 0.46, 0.57, 0.82 and 0.90, thereby validating the improvements.

Thank you !