Image Classification using Machine Learning and Deep Learning Approach

ABDULKHALEQ AYDIN A[1]

[1]*Department of Software Engineering, School of Engineering*

Ataturk University

[1]abdulkhaleqaydina.abdulkhaleq.aydin.a22@ogr.atauni.edu.tr

This Research Paper was Submitted in Fulfilment of The Requirements for

| Pattern Recognition and Machine Learning Class

Prof.Dr.Esra ODABAŞ YILDIRIM

***Abstract*— This paper demonstrates a comprehensive evaluation of six models for image classification. The dataset used in this study combines features extracted from authentic(original) and fake(templed) images. The aim of the study is to compare the performance of pursue models and identify the most effective one for image classification. The evaluation metrics that have been used in this research include accuracy, precision, recall, F1 score, and ROC AUC score. The results show that Deep Learning models outperform Machine Learning models significantly when it comes to image authenticity classification. In fact, the highest score obtained from MLP and ANN was 97.97% and 97.10% respectively, whereas Machine Learning models showed different performance, with some scoring 97% like Logistic Regression, and others achieving a disappointing score like Naive Bayes, which scored 69%. In contrast, Machine Learning models were faster than Deep Learning models when it comes to implementation (training and testing). This study demonstrates the effectiveness of the Deep learning models in accurately distinguishing between authentic and fake images.**

***Keywords*— Machine Learning, Pattern Recognition, Deep Learning, Image Classification**

I. Introduction

In recent years, digital image tampering has become more and more often , so it become crucial to develop image classification methods that are both reliable and precise. Not just that, images hold an important role in various domains. When dealing with large collections of images, it is crucial to efficiently extract relevant information within a reasonable period. In addition, the performance of image classification algorithms significantly impacts the accuracy of image categorization. In fact, there is so many algorithms exist there that deal with image classification, but each one of them has its own advantages when applied to different problems.

Traditional machine learning and deep learning algorithms each offer unique advantages for image classification. Conducting a comparative analysis of image classification algorithms based on traditional models holds endless importance in the process of selecting the most suitable algorithms for picture classification.

This research focuses on leveraging traditional machine learning and deep learning models to classify images into two categories: authentic or fake. The dataset that has been used in this study consists of a mix of features extracted from both original and ungenuine images. The goal of this classification task is to predict the target variable (y), where a value of 0 indicates bogus images, while a value of 1 refers to genuine images.

The models that have been used in this study include logistic regression, Naive Bayes, decision trees, support vector machines SVM, artificial neural networks ANN, and multilayer perceptron MLP. Each one has its own advantages and disadvantages to the classification problem, and evaluating them enables us to determine which approach holds the most promising results.

By comparing the performance of each one, we can gain insights into their abilities to differentiate between authentic and fake images. Some of the performance evaluation metrics that took under consideration were such as accuracy, precision, recall, F1 score, and ROC AUC. These metrics can show us to evaluate the models' ability to correctly classify both authentic and fake images and understand their limitations.

The findings from our study have the potential to contribute significantly to the field of image authenticity verification. By identifying the most effective models, we can improve the capabilities of automated systems in detecting image tampering and ensuring the integrity of visual content.

II. The dataset

We have two datasets in .mat file, the first one called “FA” which is conducted from “Authentic images” and the second one called “FT” which conducted from Tampered images. These two dataset represents the features of the images that it extracted from. Fa-dataset consist of (800 by 342) and the FT-dataset consist of (921 by 342). The labels in these datasetsa are numerical and doesn’t have a specific label refereing to feature name or what it represents.

By combining these two datasets using pandas concatinate functions, we get a unified dataset the will be used in our study. Firstly, we had to create a new column ineach dataset called “y” that represent the image authenticity status whether the features representing authentic or fake image. In case of authentic image, we gave the “y label” “1 value”, and “0 value” for the fake one.

Secondly, we splited the combined dataset features into “x feature” that represents “independent variables” and “y features” that represents “our target feature” the image authenticity. By doing these steps, the dataset became ready fro Explorotary Data Analysis “EDA” and other steps in the coming stages.

III. Methodology

In our purse paper we can divide our methodology to two steps:

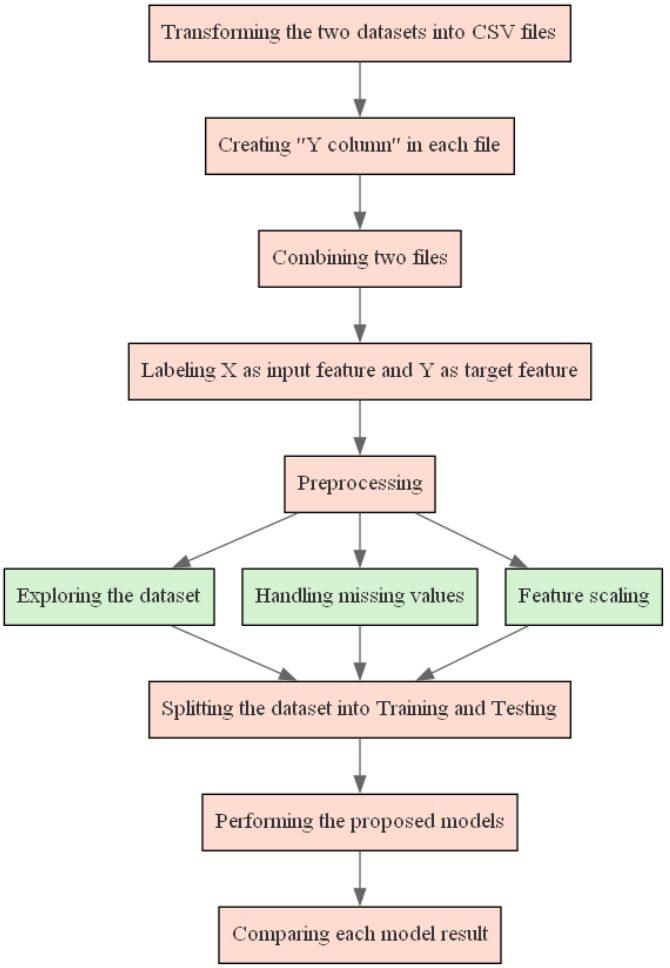

Fig1: Methodology Process

A. Having a broader look at our data(EDA)

In any machine learning process, it should begin by analysing the data, what it contains, the features and behaviours toward each other, the variance, and correlations between the variables which affect the machine learning models.

In our Exploratory Data Analysis, we looked the structure of combined dataset. Firstly, the dataset consist of (1721 by 343) with not any missing values in it. Let’s look at the classes of our target feature “y column”, it has (0 = > 921) and (1 => 800) which means, we have 121 more fake images than the authentic ones.

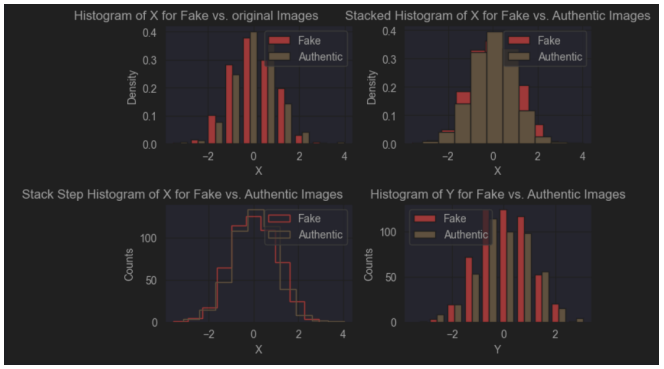

Fig2: Histogram Graph for Authentic and Fake Images

B. *Preprocessing and preparing the dataset for implications*

Then we split our dataset into training and testing by (80% for training and 20% for testing and random_seed at 42). The feature scaling techniques are applied to ensure consistent scaling across features.

C. *Applying the proposed model's*

The selected classification algorithms were trained on the preprocessed dataset and evaluated using various metrics, including accuracy, precision, recall, F1 score and ROC AUC curve. These metrics provided insights into the models' ability to accurately classify images into authentic or fake ones.

Hyperparameter Tuning: doesn't need in our case study.

IV. Results and Discussion

The image classification task on the combined dataset yielded the following results:

6 rows | 6 rows × 3 columns

	Models	Score	time
2	Naive Bayes	0.695652	0.307372
1	Decision Tree	0.805797	1.755653
3	SVM	0.953623	1.008275
4	ANN	0.971014	3.419744
0	Logistic Regression	0.976812	0.924874
5	MLP	0.979710	1.870808

Table1: The Comparisons between all models in terms of Accuracy and Time

These results indicate that the Deep Learning approach outperforms machine learning models in classifying images into authentic and fake ones, especially Multilayer Perceptron (MLP), which gave an excellent result by (%97.9). The high accuracy suggests that the model was able to make accurate predictions on the majority of the test dataset. The precision, recall, and F1 score further validate the model's performance, indicating a good balance between correctly identifying the originality of the images. In contrast, Machine learning models don't show that performance, in fact, some of the ML models were so poor during the test like Naive Bayes and Decision Tree.

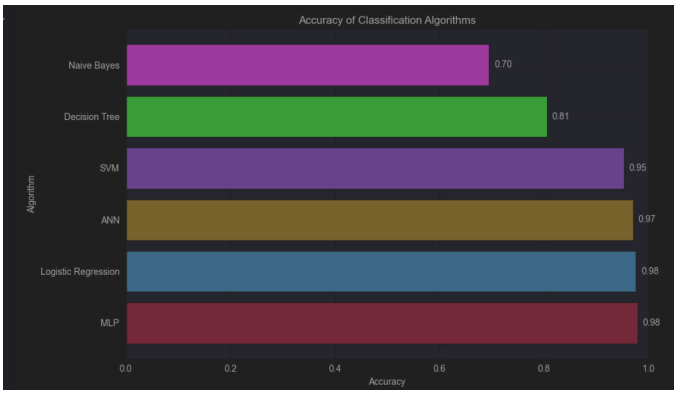

Fig3: Bar Graph Demonstrating models accuracy from worst to the best

In spite, Depp learning models gave impressive results but on the other hand, it takes a double amount of what Machine Learning ones did. Indeed, in some cases like the MLP model, which took triple that ML models took.

V. Conclusion

In conclusion, this image classification study demonstrated the effectiveness of deep learning over machine learning models in classifying images into authentic and fake pictures. Machine Learning algorithms like Logistic Regression, Decision Trees, Naive Bayes, SVM and Deep Learning ANN and MLP algorithms were evaluated, and their performance metrics were compared. Based on the results, ANN and MLP by far were the best among all the models, which emerged as the most promising approach for image classification on the given dataset, showing higher accuracy, precision, recall, and F1 score. The findings of this study contribute to the picture authenticity analysis of techniques and their application in all different domains.Future research can focus on enhancing the performance further by incorporating advanced feature engineering techniques and exploring ensemble methods.

VI. References

[1] For source code about the project and the dataset on my GitHub page: https://github.com/Dr-LazyMazy/Image_Classification_Using_ML_and_DL.git

[2] Sharma, P. and Kaur, M. (2013) Classification in Pattern Recognition: A Review. International Journal of Advanced Research in Computer Science and Software Engineering, 3, 298.\

[3] Hackeling, G. (2017). Mastering Machine Learning with Scikit-Learn (second ed.). Packt Publishing.

[4] Wang, P., Fan, E., & Wang, P. (2021). Comparative analysis of image classification algorithms based on traditional machine learning and deep learning. Pattern Recognition Letters, 141, 61-67. 10.1016/j.patrec.2020.07.0