Tifinagh RGB Character Classification using Multiclass Neural Networks

Repository: https://github.com/Ykhallouki25/TP_Classification_Tifinagh_RGB

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1. Introduction

Handwritten character recognition is a key domain in computer vision. In North Africa, the Amazigh language uses the Tifinagh alphabet,
standardized by IRCAM. This project focuses on classifying handwritten Tifinagh characters using RGB images instead of traditional grayscale inputs.
We apply multiclass neural networks to evaluate whether color data enhances recognition accuracy.

2. Methods

We use the AMHCD (Amazigh Handwritten Character Dataset), containing 28,182 images distributed over 33 classes.
Each image is resized to 32x32 pixels with 3 color channels (RGB), resulting in a 3072-dimensional feature vector.

Model architecture (MLP):
- Input: 3072 neurons (32x32x3)
- Hidden: Dense(512, ReLU) → Dense(128, ReLU)
- Output: Dense(33, Softmax)

Labels are one-hot encoded. Two optimizers are compared: Adam and SGD.
The model is trained on 80% of the data and evaluated using 5-fold cross-validation.

3. Results

Results highlight the clear superiority of the Adam optimizer over SGD. Adam achieves a test accuracy of ~89% with stable training dynamics,
while SGD reaches only ~70% and suffers from significant fluctuations and higher validation loss.

Optimizer	Test Accuracy	Final Validation Loss	Observations
Adam	~89%	Low and stable	Fast and smooth convergence
SGD	~70%	High and unstable	Slow convergence with frequent oscillations

4. Discussion

Adam's adaptive learning rate per parameter enables better handling of noisy gradients, which are common in RGB image classification tasks.
In contrast, SGD is more sensitive to local minima and requires precise tuning of its learning rate. The 5-fold validation showed Adam's consistent performance,
while SGD exhibited large variance between folds, indicating poor generalization.

Using RGB inputs introduces additional variability but offers new learning opportunities. In the future, CNNs may better capture spatial features.

5. Conclusion

This study demonstrates the effectiveness of a simple MLP architecture for RGB Tifinagh character recognition. The Adam optimizer significantly boosts performance,
providing robust convergence and better generalization. Results suggest that while RGB inputs are promising, convolutional networks could further improve recognition accuracy.