

Comparative Study Between the SVM Classic Model and Few-Shot Learning Model

1. Objective

The objective of this comparative is to validate the classic Machine Learning (Support Vector Machine - SVM) model and the model adopted for this project (Few-Shot Learning).

The central challenge of this project is the classification of EEG signals for the detection of Burnout. To ensure clinical validity, the Subject Isolation protocol was adopted:

- For training, it was divided into 80% of patients.
- For testing, it was divided the remaining 20%.

This ensures that the model is evaluated for its ability to generalize to new individuals, rather than memorizing specific patterns from training patients.

2. Explanation of the Classic SVM Model

SVM is a classic supervised learning algorithm, widely used in biological signal classification due to its efficiency in high-dimensional spaces.

SVM seeks to find an **optimal hyperplane** that separates classes (in this case, "Relaxed" and "Burnout") with the largest possible margin.

- In this study, the **Linear** Kernel was used. This means that the model attempts to draw a straight line (or plane) to separate the data.
- The input for the SVM was the flattened vector of the spectrogram characteristics.

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3. Explanation of the Few-Shot Learning Model

The main model of the project uses a **Deep Learning** approach based on Prototypical Networks. Unlike traditional classification, this model learns a metric space where distances correspond to semantic similarity.

How it works:

- **Embedding (CNN):** A Convolutional Neural Network extracts the deep features of the EEG signal, transforming a matrix (Channels x Time x Frequency) into a compact vector.
- **Prototype Calculation:** The model calculates the midpoint (centroid) of each class in the vector space. This midpoint is called the **Prototype**.
- **Classification via Distance:** To classify a new sample, the model calculates the **Euclidean Distance** between the sample and the prototypes. The sample is assigned to the class of the nearest prototype.

Theoretical Advantage By learning the geometry of classes rather than fixed boundaries, Few-Shot Learning is theoretically better able to generalize the concept of Burnout to new patients, even with few examples.

#4. Result: The tests were performed under the same preprocessing and data splitting conditions (Subject Isolation).

Metric	SVM	Few-Shot	Difference
Acurácia	75.95%	89.40%	+13.45%
F1-Score	~0.76	~0.89	+0.13

Confusion Matrix Analysis (SVM)

The SVM exhibited the following behavior in the test data:

```
[[257 113] -> Relaxed (113 Falsos Positivos)
 [ 58 283]] -> Burnout (58 falsos Positivos)
```

It is observed that SVM tends to generate many **False Positives** (classifying relaxed subjects as burnout), which indicates a difficulty in separating natural brain noise from pathological patterns in unknown patients.

Conclusion

The results demonstrate the statistical superiority of the **Few-Shot Learning** model for this task.

While SVM suffered a degradation in performance when faced with unseen subjects (falling to ~76%), the Prototypical Neural Network maintained high robustness (~89%). This confirms the hypothesis that deep feature extraction (Deep Learning) combined with distance-based learning (Few-Shot) is more suitable for dealing with the high variability of EEG signals among different humans.