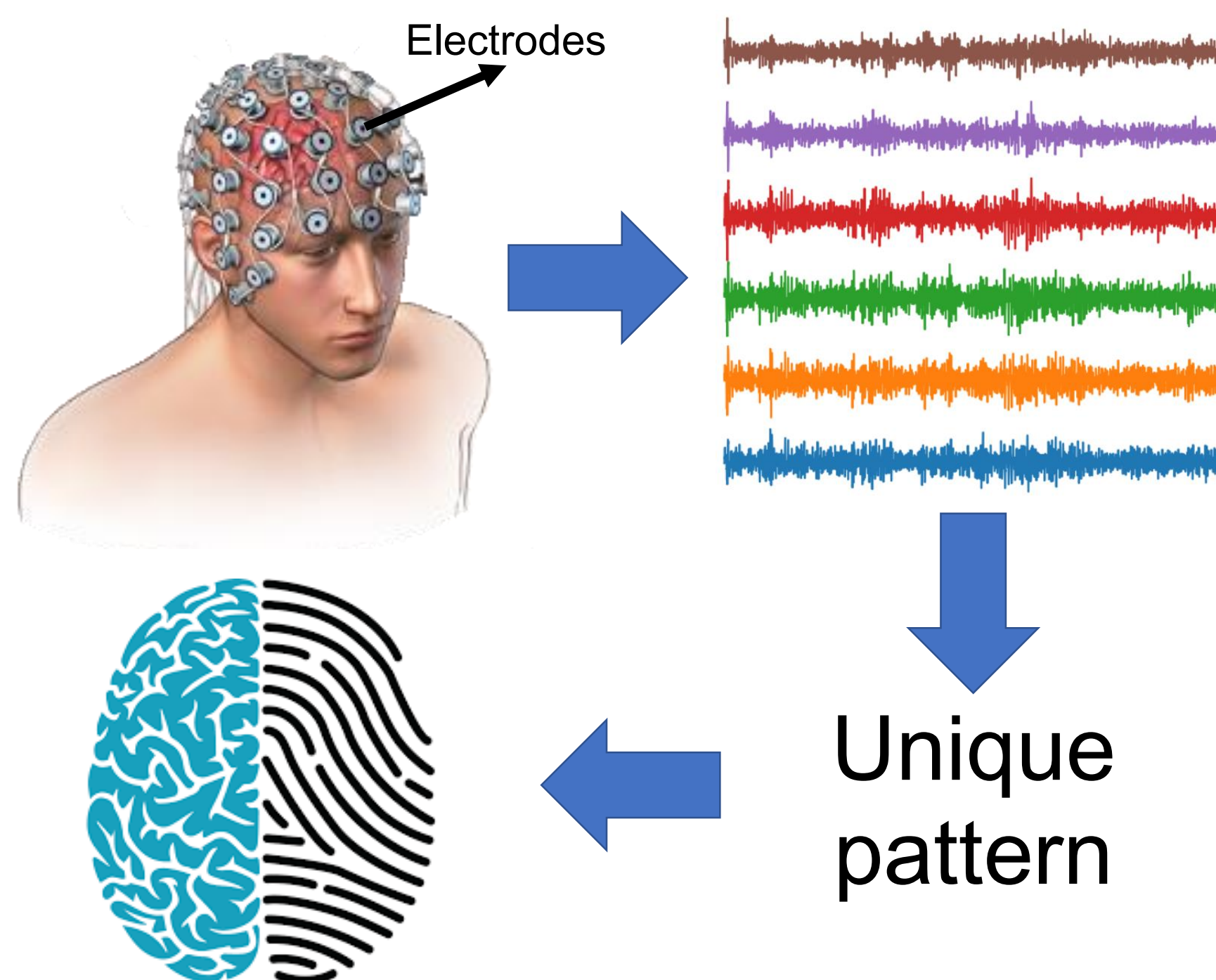


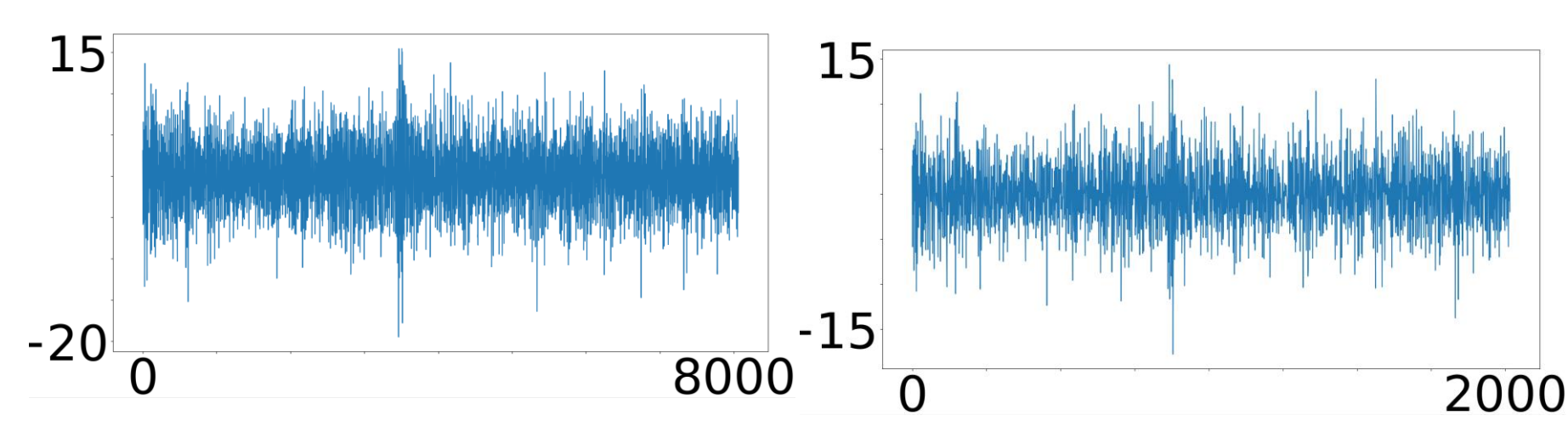
Introduction

Electroencephalography is a non-invasive electro-physiological monitoring method that records the electrical activity of the brain.



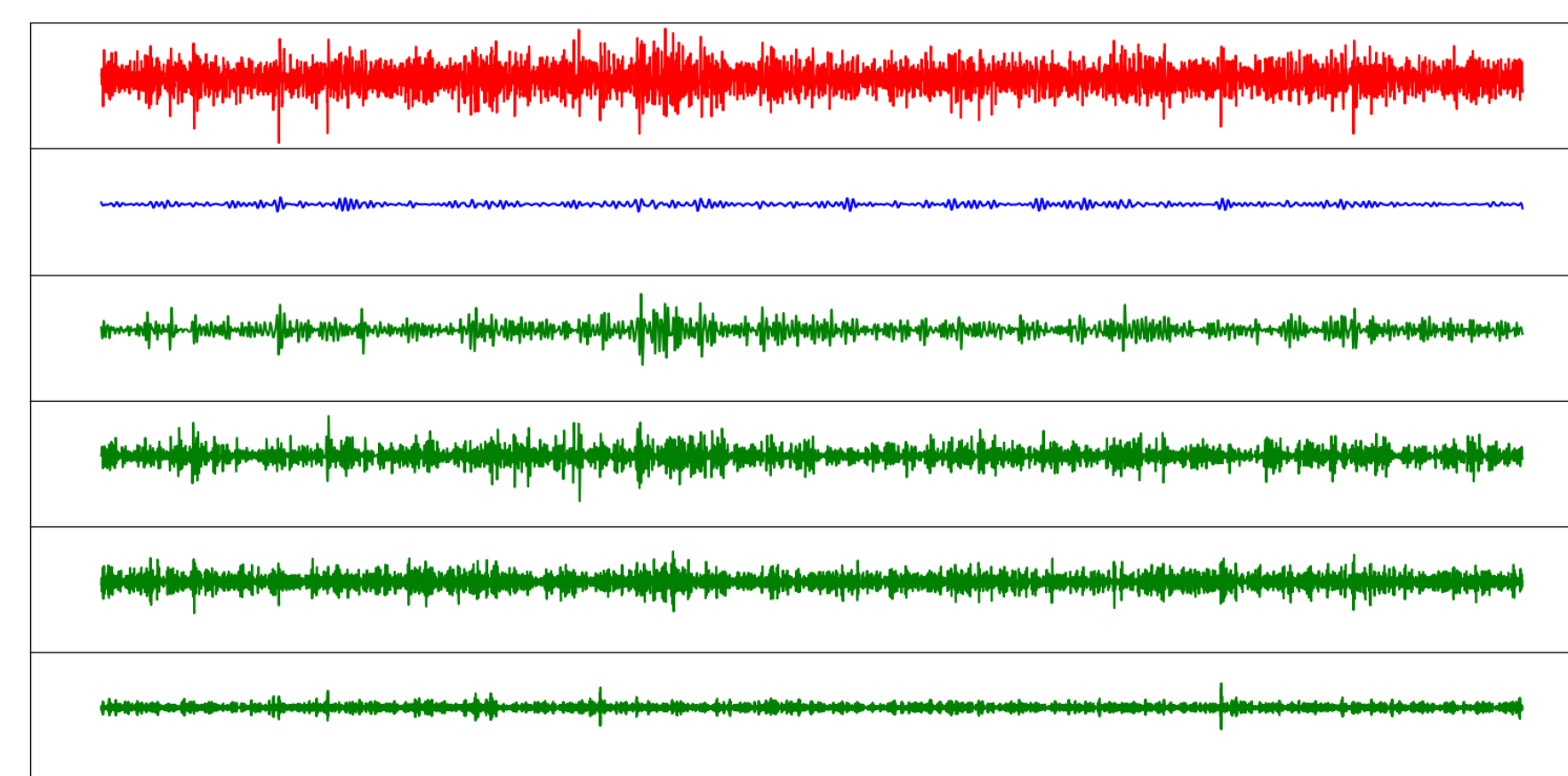
Pre-processing

1. Downsampling (512 to 128 Hz).



2. Electrooculographic removal.

3. Discrete wavelet transform.



Feature Extraction

Relative wavelet energy (RWE) was chosen as a feature because it has been shown to be very useful in classification tasks. The energy of each sub-band was computed using the following equations:

$$E_{D_i} = \sum_{j=1}^N |D_{ij}|^2, i = 1, 2, 3, \dots, L$$

$$E_{A_L} = \sum_{j=1}^N |A_{Lj}|^2$$

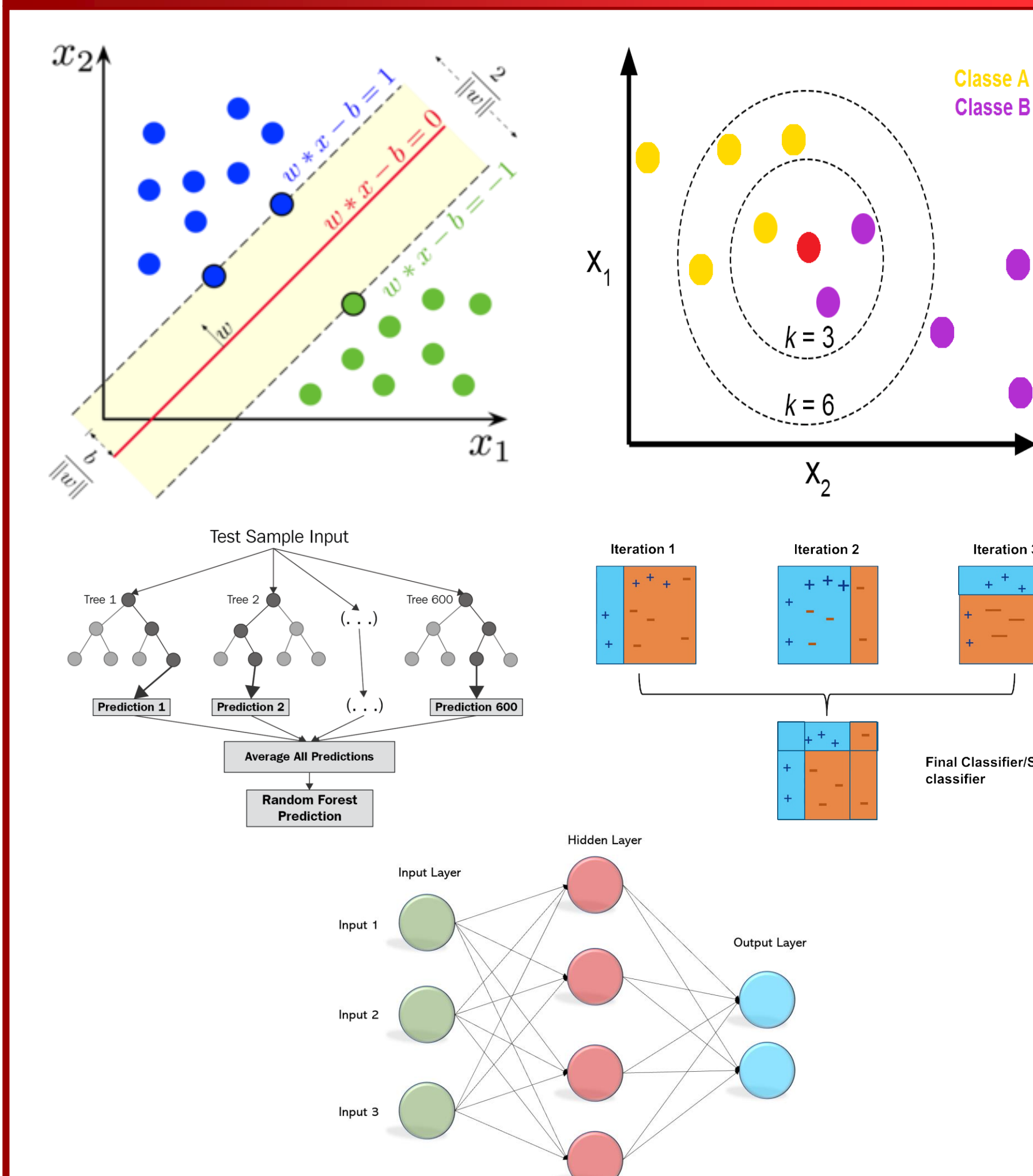
where N is the length of the coefficient vector and L is the maximum level of decomposition. Using the previous equations, the total and relative energy are defined as:

$$E_T = \left(\sum_{i=1}^L E_{D_i} \right) + E_{A_L}$$

$$E_R = E_i / E_T$$

where $E_i = E_{D_{j=1, \dots, L}} \text{ or } E_{A_{j=L}}$.

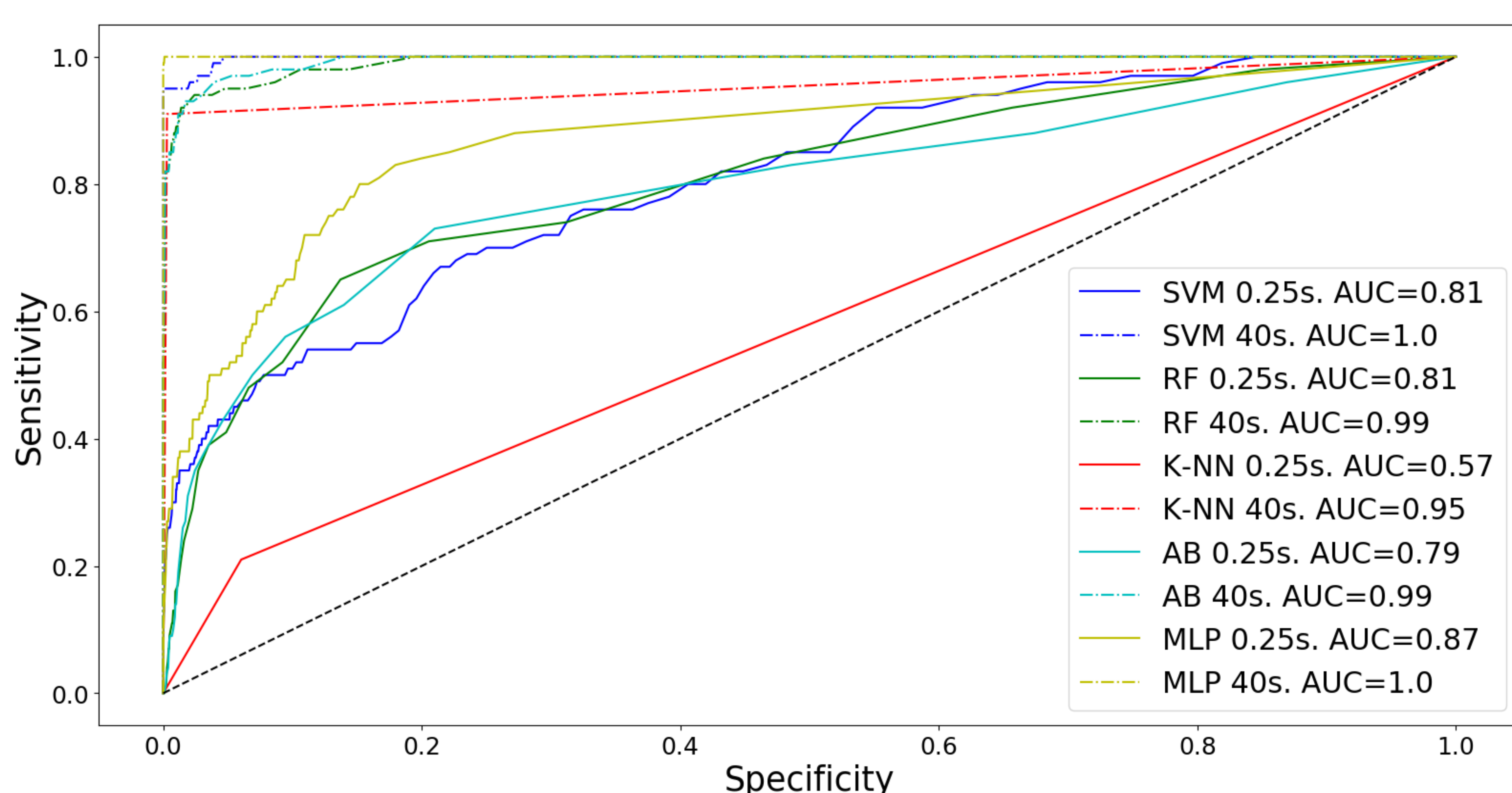
User Identification



Results

Time (Sec)	SVM (%)	RF (%)	KNN (%)	AB (%)	ANN (%)
0,25	59,88±2,55	53,25±2,23	37,00±2,40	52,69±2,69	61,97±2,40
0,5	70,25±2,13	59,09±2,24	45,19±3,49	59,84±2,77	73,78±1,79
1	79,34±2,79	70,91±1,58	58,81±1,60	70,38±1,94	83,63±1,31
2	88,31±1,66	79,69±2,42	72,38±2,23	78,84±2,16	92,25±1,92
4	93,75±1,41	87,72±1,77	82,91±1,88	87,31±1,63	96,47±1,37
6	95,44±0,81	90,31±1,55	86,25±1,56	90,59±1,33	97,81±0,93
8	96,69±1,00	91,81±1,56	89,13±0,92	92,31±1,06	98,47±0,45
10	97,66±0,82	93,16±1,12	89,97±1,85	92,44±1,28	98,56±0,37
20	98,94±0,61	95,25±1,10	95,53±0,84	95,06±1,55	99,72±0,23
30	98,88±0,40	96,47±1,04	95,97±1,01	96,22±0,88	99,53±0,37
40	99,31±0,48	96,81±0,94	96,81±0,52	96,84±0,71	99,75±0,25
50	99,47±0,42	97,66±0,68	97,75±0,56	97,88±0,87	100,00±0,00
60	99,47±0,28	98,00±1,17	98,31±0,83	97,94±1,05	100,00±0,00

Results



Conclusions

- Our main contribution is the comparison and analysis between different times of EEG recordings.
- A viable biometric system based on EEG could be developed using only 2 seconds of recording, but if we increase the recording duration the system becomes extremely secure.
- The implementation of multimodal biometrics systems using signals of other sources could increase the accuracy with short times. For this reason, we propose it as future work.