pyRiemann-qiskit

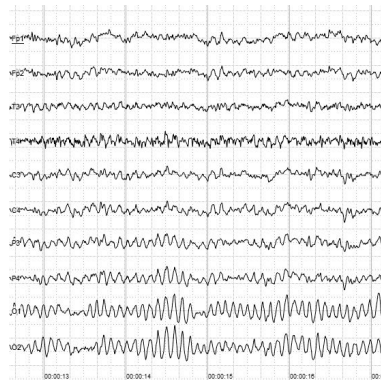https://github.com/pyRiemann/pyRiemann-qiskit

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What is it for?

Time series classification:

- Biosignals
  - EEG (Brain waves)
- Sensors
- Finance (example code available)
- …

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How to cite?

Anton Andreev, Grégoire Cattan, Sylvain Chevallier, and Quentin Barthélemy. 'pyRiemann-qiskit: A Sandbox for Quantum Classification Experiments with Riemannian Geometry'. Research Ideas and Outcomes 9 (20 March 2023). https://doi.org/10.3897/rio.9.e101006

pyRiemann & Qiskit integration

Algorithms based Riemannian geometry:

- SOTA biosignal classification
- Computationally fast
- Independent to time epoch length
- Robust
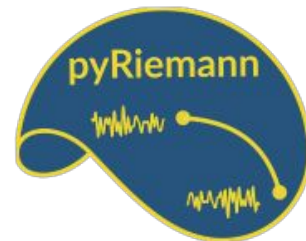
Algorithms based on Quantum computing:

- Can solve optimization problems
- Try when classical fails
  - noisy signal or BCI illiteracy
- Exploits the combination of classical and quantum classifiers
  - Hybrid methods

Quantum-MDM

Training

Signal to ERP Covariances

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Building centroids using Riemannian geometry

Classification (classical)

Choosing distance (e.x. Riemannian)
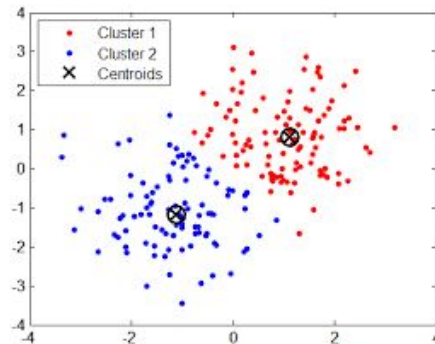
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Calculate the distance to centroids

Classification (quantum)

Distance is represented as QUBO optimization problem

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Qiskit Solved by QAOA

More quantum hybrid pipelines

- Quantum MDM
  - where quantum is used to estimate the centroids
- VQC
- QSVM
- Voting Classifier

Demo

Link: https://colab.research.google.com/drive/1dB1CcUcS_yAVZ14gzyfZkLN0D3tsqmh4

Experience on real quantum computer:

- Training is slow due to usage limitations
  - Many quantum jobs are needed
  - Each quantum job is queued
- Classification score can be low due to:
  - Low number of "shots"
  - Too small feature vector (depends on available quantum bits)
  - Not sufficient data