

Mother of All BCI Benchmarks

Cortico Minischool

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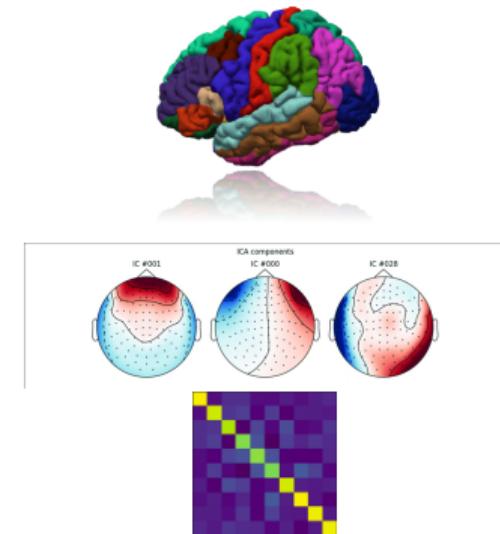
Why open source matters

Reproducibility issues

Freesurfer Popular software for extracting features from MRI
→ Software variation lead to different conclusions

ICA Popular matrix factorization problem
→ Different results with different machines

eigs/eigsh Popular solver for eigenvalues decomposition
→ Solvers can lead to different outcome



Neurophysiological analysis is complex, require advanced processing
⇒ **Need for collective efforts to build open science**

Why Do We Need MOABB?

Reproducible research in BCI has a long way to go...

- Unavailable code
- Exotic data format/language/toolboxes
- Preprocessed data (including errors)

No comprehensive benchmark of BCI algorithms

Huge waste of time for everyone

⇒ **MOABB aims to be the standard benchmark for any new paper**

- Comprehensive benchmark of popular BCI algorithms
- Extensive list of freely available EEG datasets
- Ranking algorithms with fair evaluations

MNE

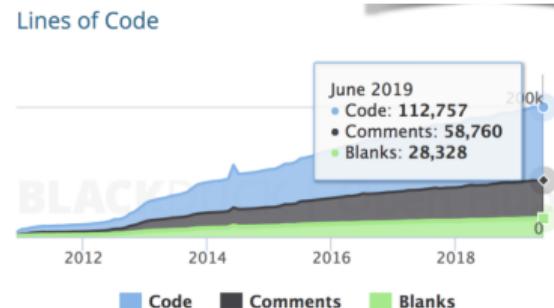
<https://github.com/mne-tools/mne-python>

History

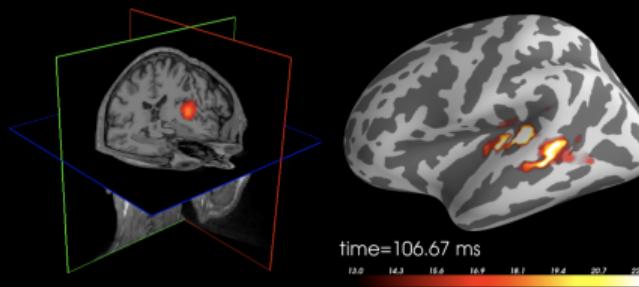
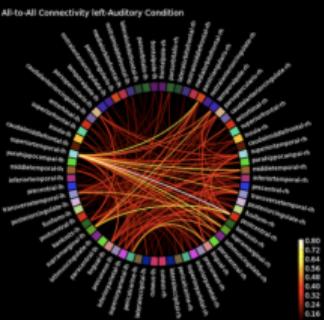
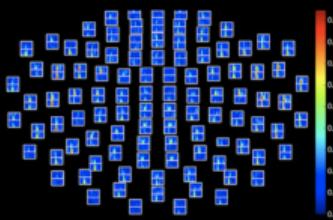
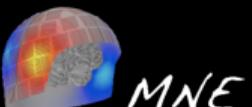
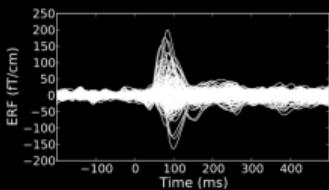
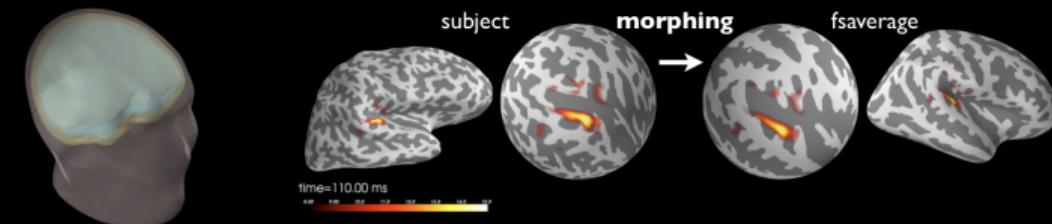
- based on C code developed for 18 years by Matti Hämäläinen
- Python started in 2010 at MGH, Boston

In a nutshell

- 236 contributors, 100k LOC
- mature codebase, large dev team
- ~ 29 years of efforts (COCOMO)



⇒ BSD licensed (commercial use ok)
⇒ Mac / Linux / Windows



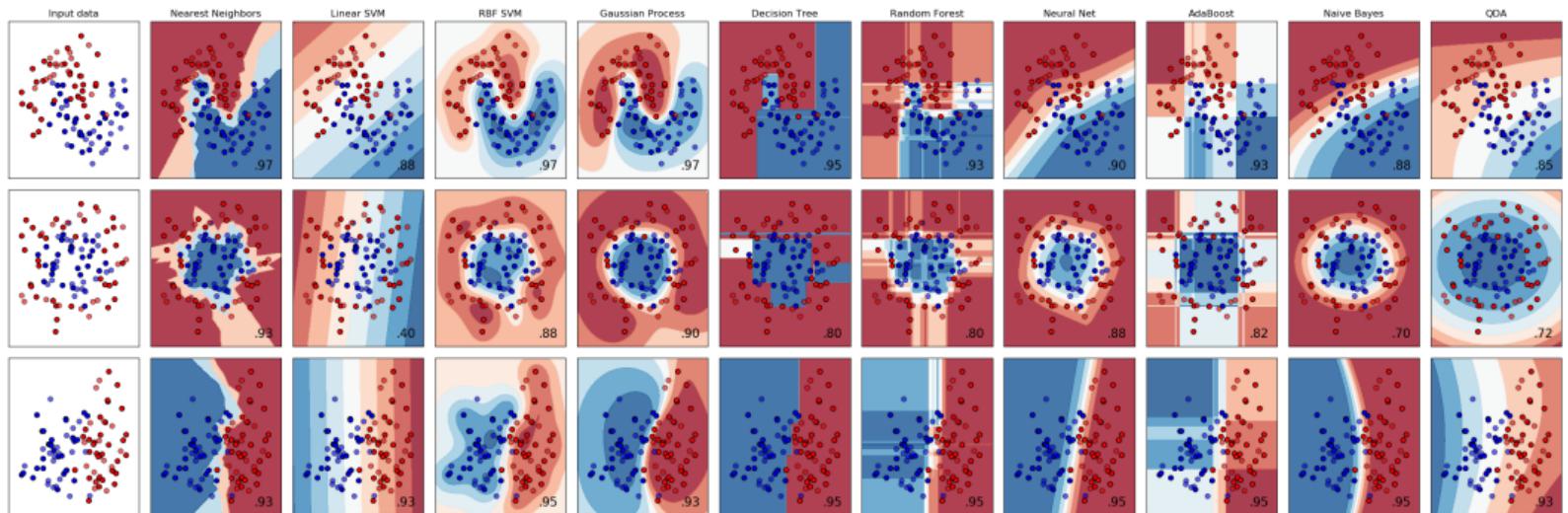
Scikit-learn – accessible machine learning

<http://scikit-learn.org>

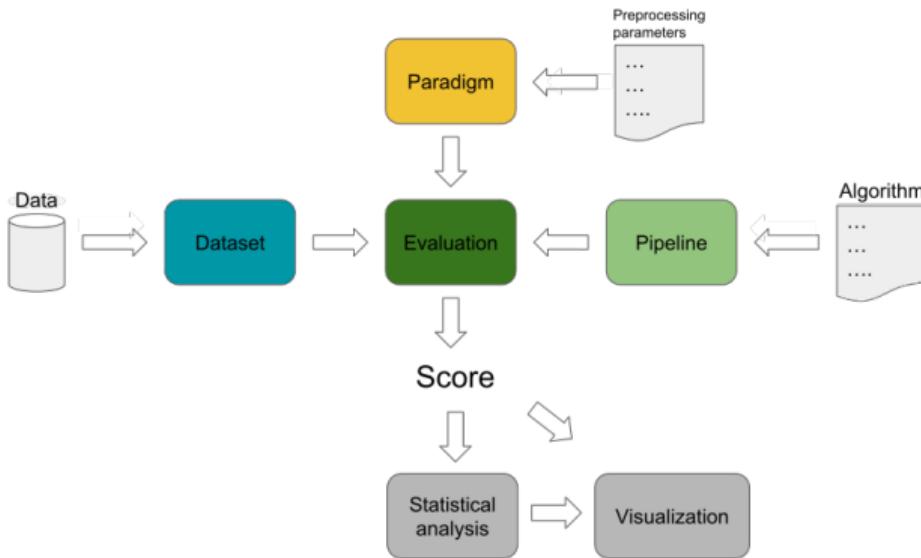
- **Machine learning for all**
⇒ No specific application domain
⇒ No requirements in machine learning
- **High-quality Pythonic software library**
⇒ Interfaces designed for users
- **Community-driven development**
⇒ BSD licensed, very diverse contributors

Easy as py:

```
from sklearn import svm
classifier = svm.SVC()
classifier.fit(X_train, Y_train)
Y_test = classifier.predict(X_test)
```



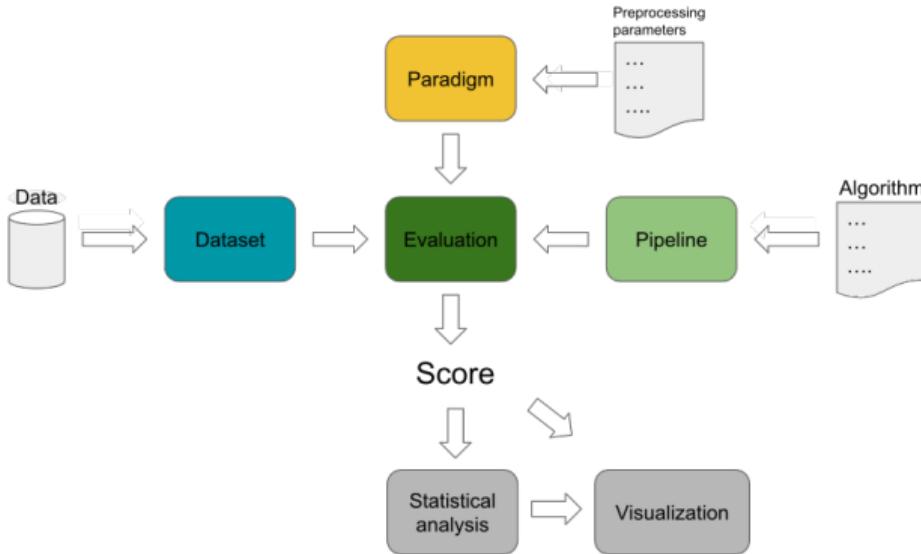
MOABB Architecture: Datasets



Dataset

- Stored locally, converted in MNE format
- Pick only subjects/sessions you need

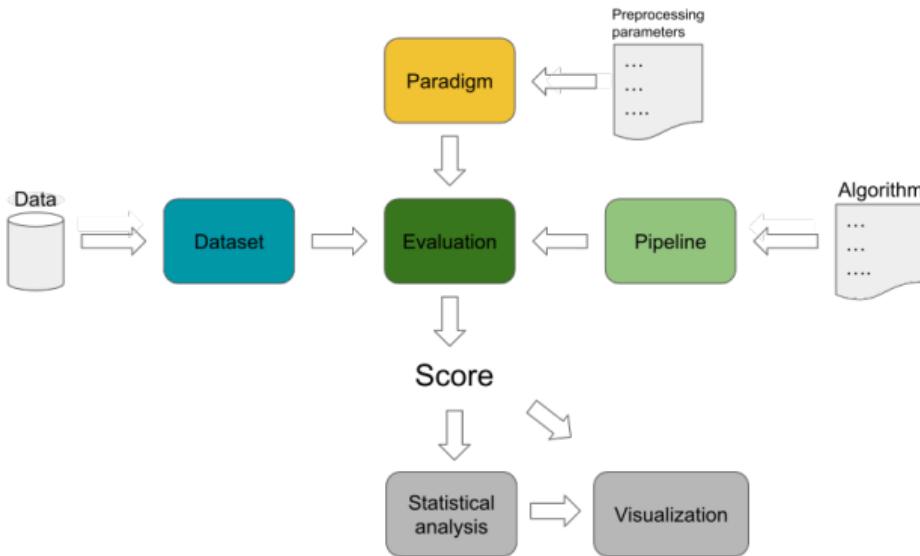
MOABB Architecture: Paradigm



Paradigm

- Motor Imagery, P300, SSVEP
- Preprocessing

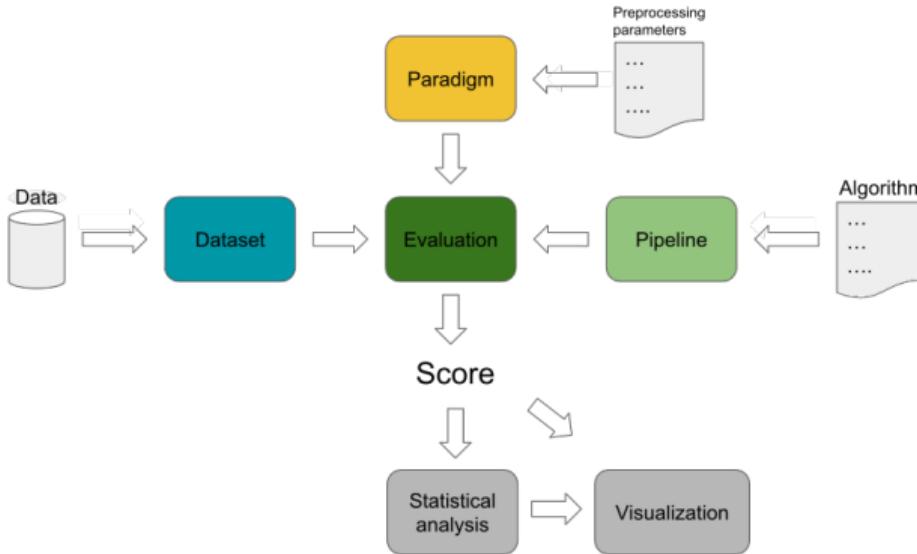
MOABB Architecture: Evaluations



- Defines a scoring method (AUC, accuracy, ...)
- within or across session, across-subject, ...

Evaluations

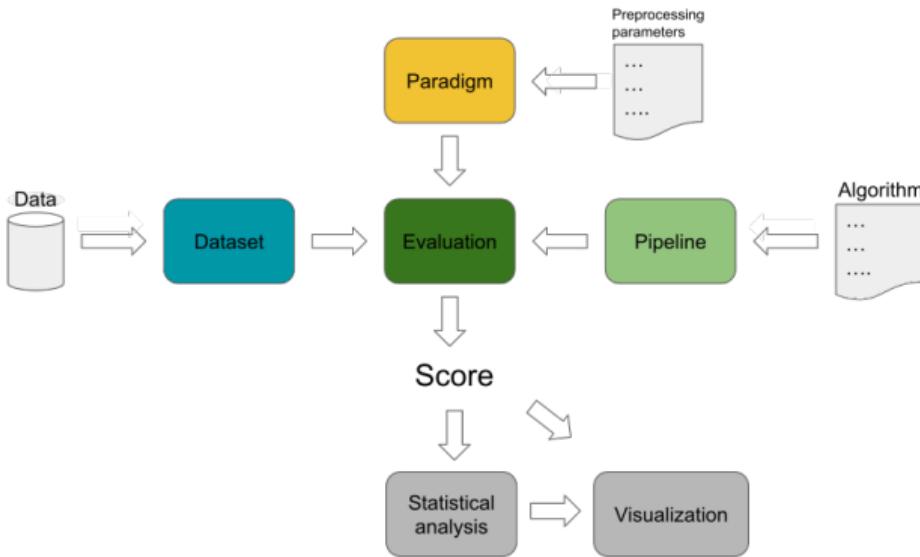
MOABB Architecture: Pipelines



Pipelines

- All steps required for obtaining a prediction
- Scikit-learn style

MOABB Architecture: Results

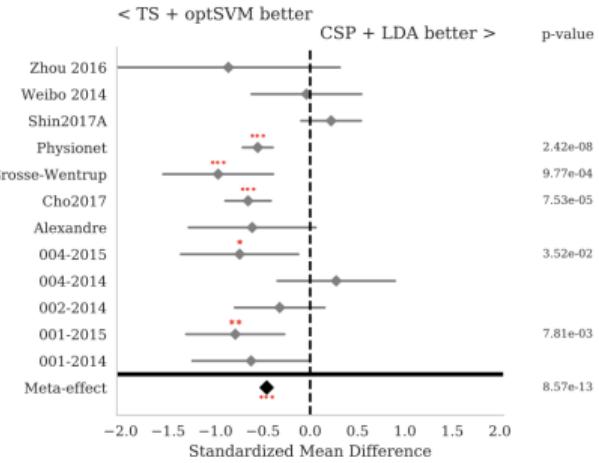


Results

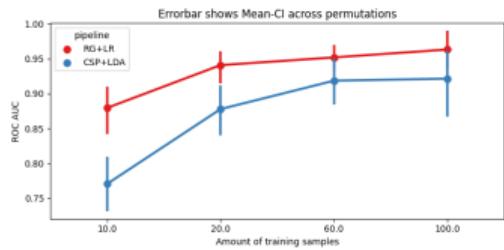
- Statistics & visualization
- Results are stored in a DataFrame

Fair and Reproducible Benchmarks

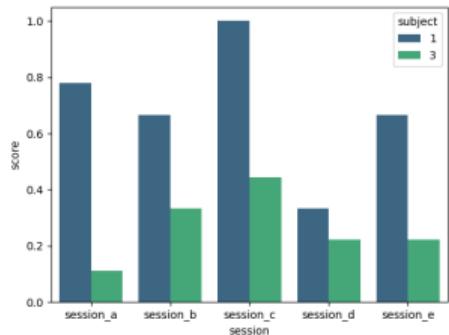
- ➊ Load multiple datasets
- ➋ Apply pipelines
- ➌ Run meta-analysis and plot



What's new? One year perspective



NeurIPS data competition beetl.ai
for transfer learning in BCI



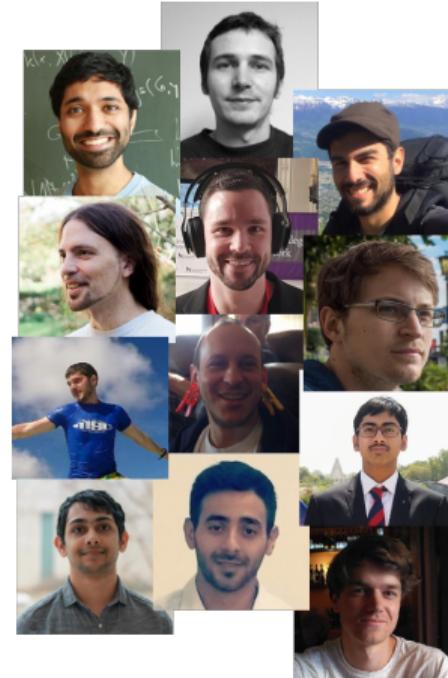
- Support latest python, MNE and sklearn version
- New datasets: 6 for SSVEP, 2 ERP, 1 MI
- New pipelines: TRCA and Riemannian for SSVEP
- Better download support with pooch
- Learning curves

An NTX Community Project

Founders: Alexandre Barachant, Vinay Jayaram

Contributors:

- Pedro Rodrigues
- Sylvain Chevallier
- Justin D. Harris
- Jan Sosulski
- Erik Bjäreholt
- Divyesh Narayanan
- Pierre Guetschel
- Vladislav Goncharenko
- Ali Abdul Hussain
- Ramiro Gatti
- Lucas Custódio
- Robin Schirrmeyer
- Mohammad Mostafa Farzan
- Yannick Roy, Morgan Hough
& the incredible NTX community
- You!



How To Contribute

Check the github and the documentation

- <https://github.com/NeuroTechX/moabb>
- <https://neurotechx.github.io/moabb/>

Discuss during Office Hours or on Gitter

- <https://github.com/NeuroTechX/moabb/issues/191>
- https://gitter.im/moabb_dev/community

Possible contributions:

- Add working examples and use cases
- Populate leaderboard and run benchmarks
- Contribute to transfer learning, TF/PyTorch integration, ...

Thank you !