

Mother of All BCI Benchmarks: An overview

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Why open source matters

Freesurfer Popular software for extracting features from MRI

<https://surfer.nmr.mgh.harvard.edu/>

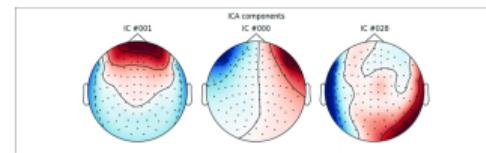
→ Hardware discrepancies lead to different scientific conclusions



ICA Popular matrix factorization problem

<https://github.com/mne-tools/mne-python/issues/4922>

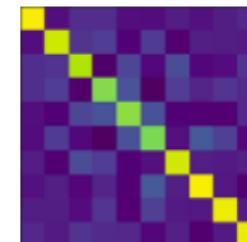
→ Different results with different machines



eigs/eigsh Popular solver for eigenvalues decomposition

<https://github.com/scikit-learn/scikit-learn/issues/5545>

→ Numerical solvers can lead to different outcome on the same machine



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 algorithm
- Extensive list of freely available EEG datasets
- Ranking algorithms with fair evaluations



MNE

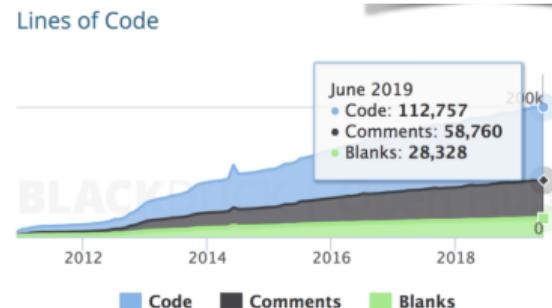
<https://github.com/mne-tools/mne-python>

History

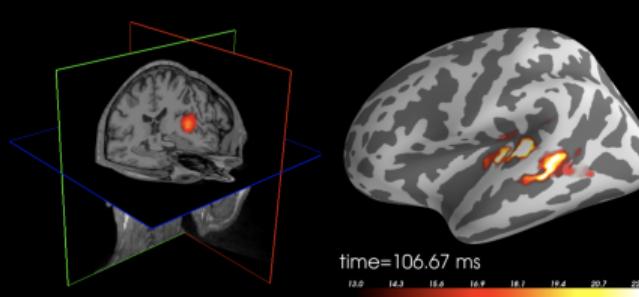
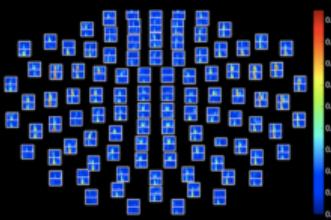
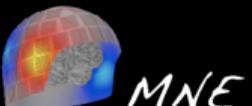
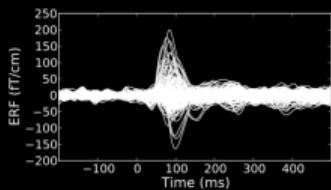
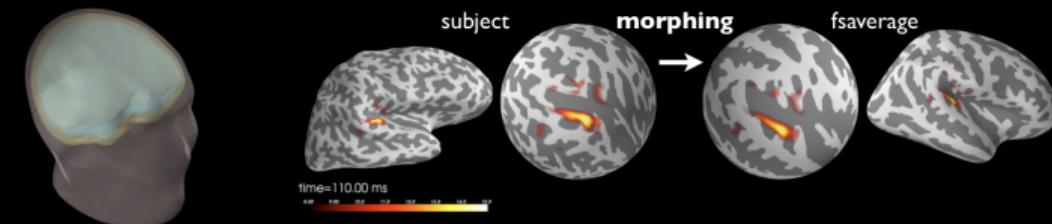
- based on C code developed for 18 years by Matti Hämäläinen
- Python started in 2010 at MGH, Boston

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





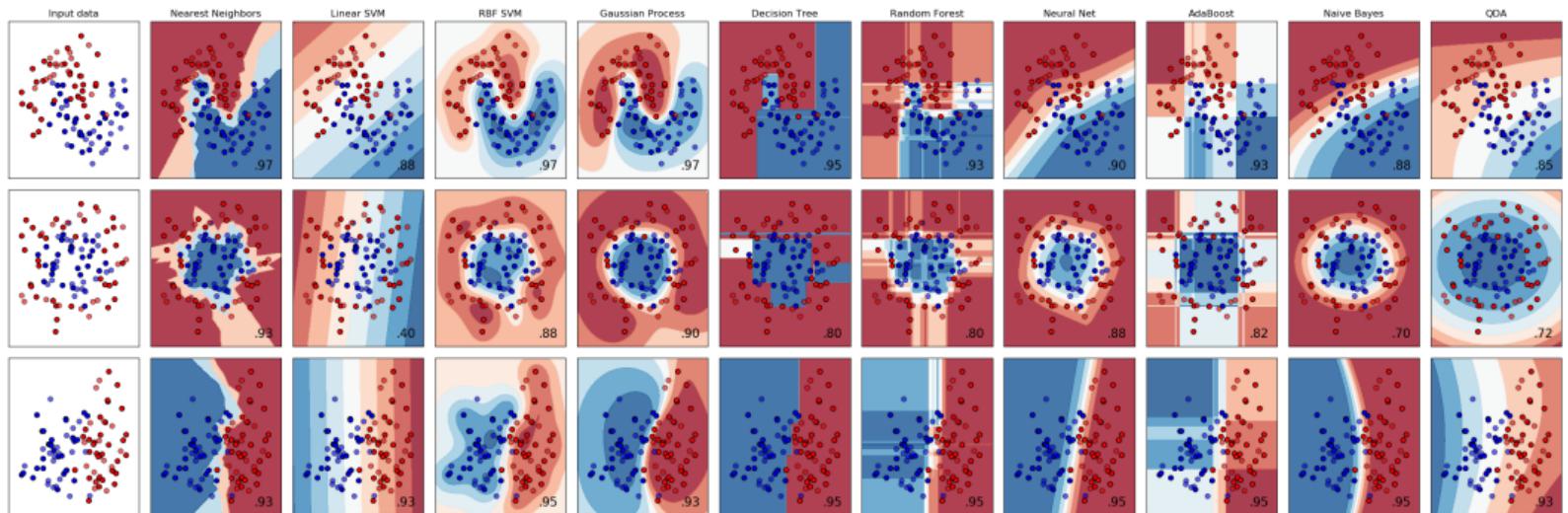
Scikit-learn vision

<http://scikit-learn.org>

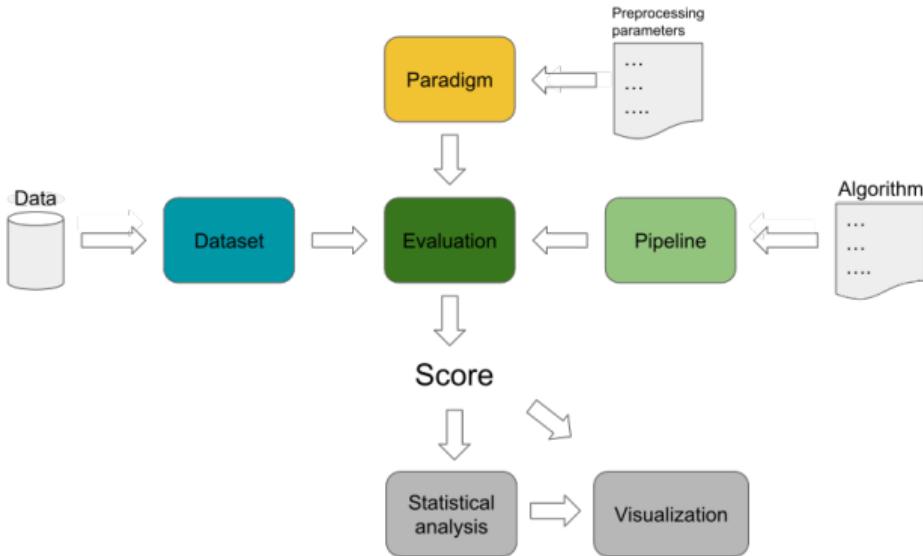
- **Machine learning for all**
⇒ No specific application domain
⇒ No requirements in machine learning
- **High-quality Pythonic software library**
⇒ Interfaces designed for users
- **Community-driven development**
⇒ BSD licensed, very diverse contributors

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

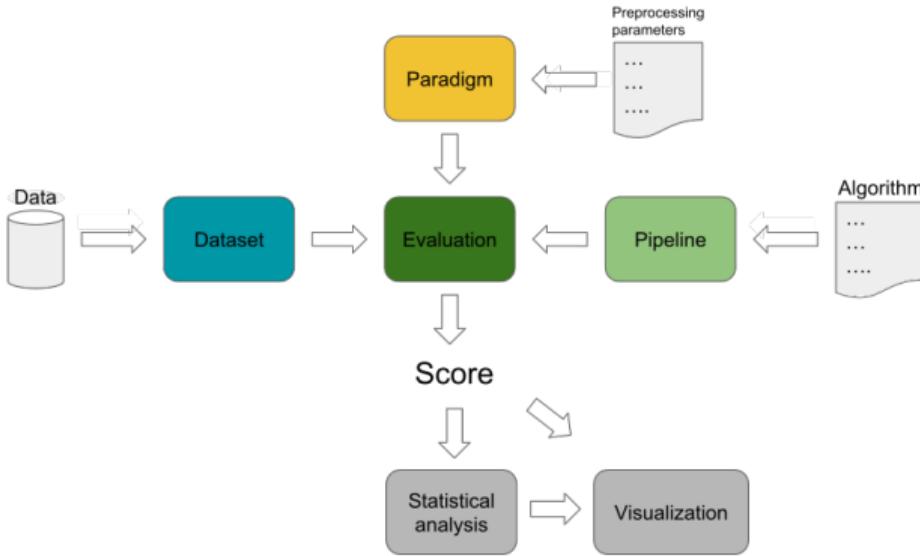


Dataset

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



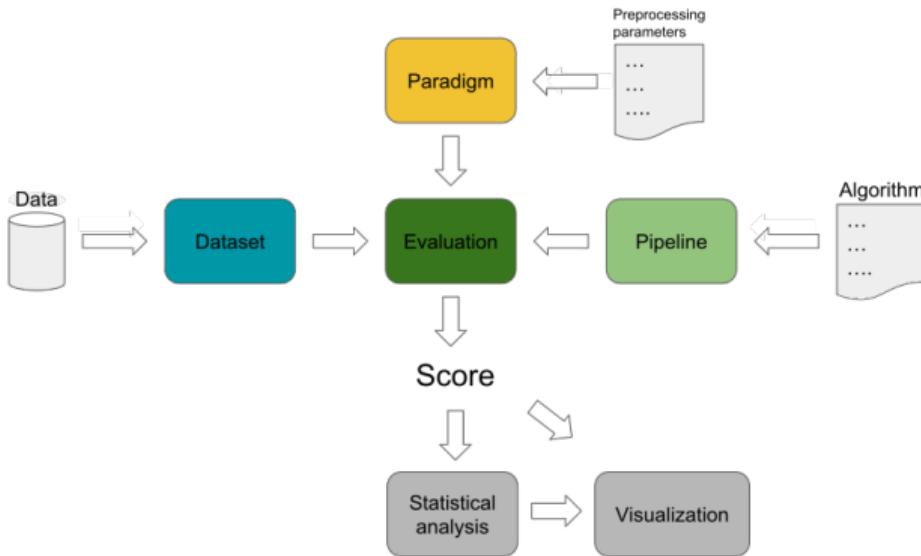
MOABB Architecture: Paradigm



Paradigm

- Motor Imagery, P300, SSVEP
- Preprocessing

MOABB Architecture: Evaluations

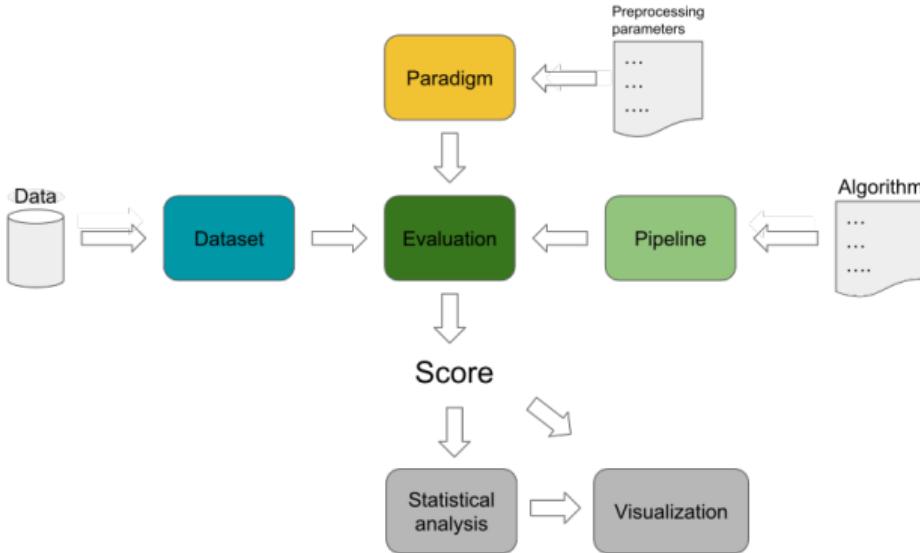


Evaluations

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



MOABB Architecture: Pipelines

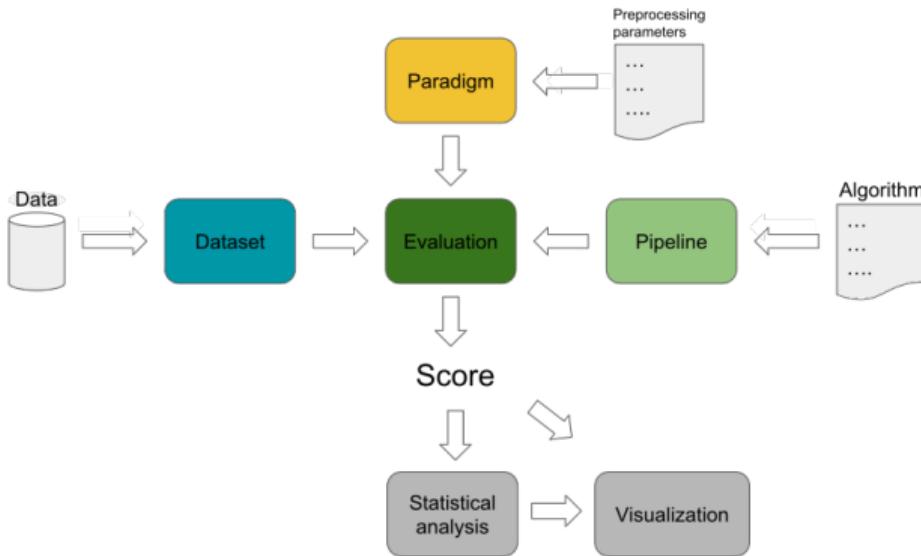


Pipelines

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



MOABB Architecture: Results

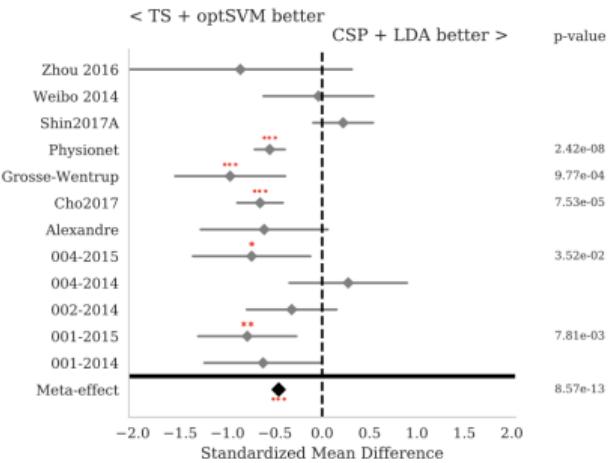


Results

- Statistics & visualization
- Results are store in a DataFrame

Fair and Reproducible Benchmarks

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





An NTX Community Project

Founders: Alexandre Barachant, Vinay Jayaram

Contributors:

- Pedro Rodrigues
- Sylvain Chevallier
- Justin D. Harris
- Jan Sosulski
- Erik Bjäreholm
- Divyesh Narayanan
- Yannick Roy, Morgan Hough
& the incredible NTX community
- You!





How To Contribute

Check the github and the documentation

- <https://github.com/NeuroTechX/moabb>
- <http://moabb.neurotechx.com/docs/index.html>

Discuss on office hours (Thursday at 19:30 CET) and Gitter

- <https://www.meetup.com/fr-FR/CogLab/>
- 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 !