Practicum: Extending BCILAB and Implementing Custom Methods

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Outline

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2. BCI Paradigm Plugins
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3. Machine Learning Plugins
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4. Signal Processing Plugins
   1. Implementing Delay Embedding
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Concrete Case Study

- **Goal**: Implement a method that can predict continuous target values based on brain oscillations
  - Learns spatial filters
  - Learns frequency weighting
- **Data**: Predict time-on-task target variable in imagined-movements dataset `userdata/imag.set`
- **Script**: Use `scripting_tutorial.m`, section *Data Curation Example II*
2.1 BCI Paradigm Plugins

Implementing SPoC
The SPoC Algorithm

• Recent method: Dähne, S., et al., SPoC: A novel framework for relating the amplitude of neuronal oscillations to behaviorally relevant parameters, NeuroImage (2013)

• Generalization of CSP to regression settings, similar implementation
  – Start from ParadigmCSP
3.1 Machine Learning Plugins

Implementing Ridge Regression
Ridge Regression

• Regression with l2 regularization
• Implementation available on Wikipedia\(^1\)
• Start from a short/simple existing plugin: ml_trainsvmperf/ml_predicts()mper()f
• Introduces a regularization parameter (set to 1 by default)

\(^1\): [http://en.wikipedia.org/wiki/Tikhonov_regularization](http://en.wikipedia.org/wiki/Tikhonov_regularization), 4\(^{th}\) equation
4.1 Signal Processing Plugins

Implementing Delay Embedding
Delay Embedding

- Idea: stacking delayed versions of the signal into multiple channels
- Allows to generalize linear spatial models to linear spatio-temporal models which can implement temporal filters, e.g., FIR filters
- Known to work well with CSP, see: Lemm, Steven, et al. *Spatio-spectral filters for improving the classification of single trial EEG*, Biomedical Engineering, IEEE Transactions on 52.9 (2005): 1541-1548 – should work with SPoC, too
- Can be implemented on epoched signals or continuous signals – for simplicity, start from simple epoch-based filter (flt_fft\(^1\))

\(^1\): note, independent_channels must be changed to false
5 GUI Check
GUI Check

• Last step in making a BCILAB plugin – check whether the GUI for your plugins is correct
  – Paradigm Dialog comes up without error?
  – Review/Edit panel comes up without error?
  – Method and parameter help text detailed enough for users?