# Automated Source Classification and Real-time ICA

# Outline

- Automatic Source Classification
  - What is it?
  - Why use it?
  - How to develop it?
- Real-time ICA
  - Compared to other forms of ICA
  - Benefits
  - Real-time EEG Source-mapping Toolbox (REST)
  - Demo

What is it?

Determining the general origin of an EEG component's activity in an automated fashion.

Heart

Eve



RV: 19.6%

Time (ms)

RV: 13.5% DMR:4.1 60

Frequency (Hz)



Why use it?

Why use it?

Automated pipelines (We will see an example situation where it would be useful later)



Why use it?

Large studies (to characterize ICA decompositions)



Why use it?







- Find all datasets on SCCN server matching the following criterion
  - ICA decomposition already attached
  - Known electrode configuration (or subset thereof)
  - Unique ICA / data combination
  - > 23,000+ datasets with 2M+ components
  - > 6,000+ datasets with 300,000+ components with unique ICA decompositions







#### An example use case: Real-time ICA

ICA is generally applied offline, after data collection is complete.

But thinking about what is usually applied before ICA:

- 1. Re-referencing Easy (and optional)
- 2. Filtering Easy
- 3. Artifact rejection Artifact Subspace Reconstruction (ASR)

These all have real-time capable implementations!

# Adaptive source model

	<b>Conventional ICA</b>	Multi-model ICA	Adaptive ICA
Data assumption	(spatially) stationary	quasi-stationary	non-stationary
Brain state hypothesis	single	discrete (predefined state)	continuous
Online capability	offline	offline	online



Sourcespace (s)







ORICA approaches performance of Infomax ICA at low computational cost for stationary EEG In fact, derived from same initial principle.



Mutual Information Reduction  $MIR = I(x) - I(y) = \log |\det W| + [h(x_1) + \dots + h(x_N)] - [h(y_1) + \dots + h(y_N)]$ 

Hsu et al. IEEE NER, 2015

# Real-time Independent Component Analysis

Benefits:

- Provides a constantly updating estimate of the ICA decomposition
- Can be used to model nonstationarity in the data



# Real-time Independent Component Analysis

Detriments

- Requires time to converge
  - depends on number of channels being decomposed
- Introduces ambiguity (which decomposition is more representative?)



# Real-time EEG Source-mapping Toolbox (REST)

Provides a graphical interface for applying ORICA to a live LSL data-stream built on top of BCILAB (and therefore EEGLAB)



# **REST Demo!**