

# Automated Source Classification and Online ICA

Luca Pion-Tonachini

2018 EEGLAB Workshop

# Outline

## Automated Source Classification

- Significance of IC classification
- What makes an IC classifier good
- ICLabel

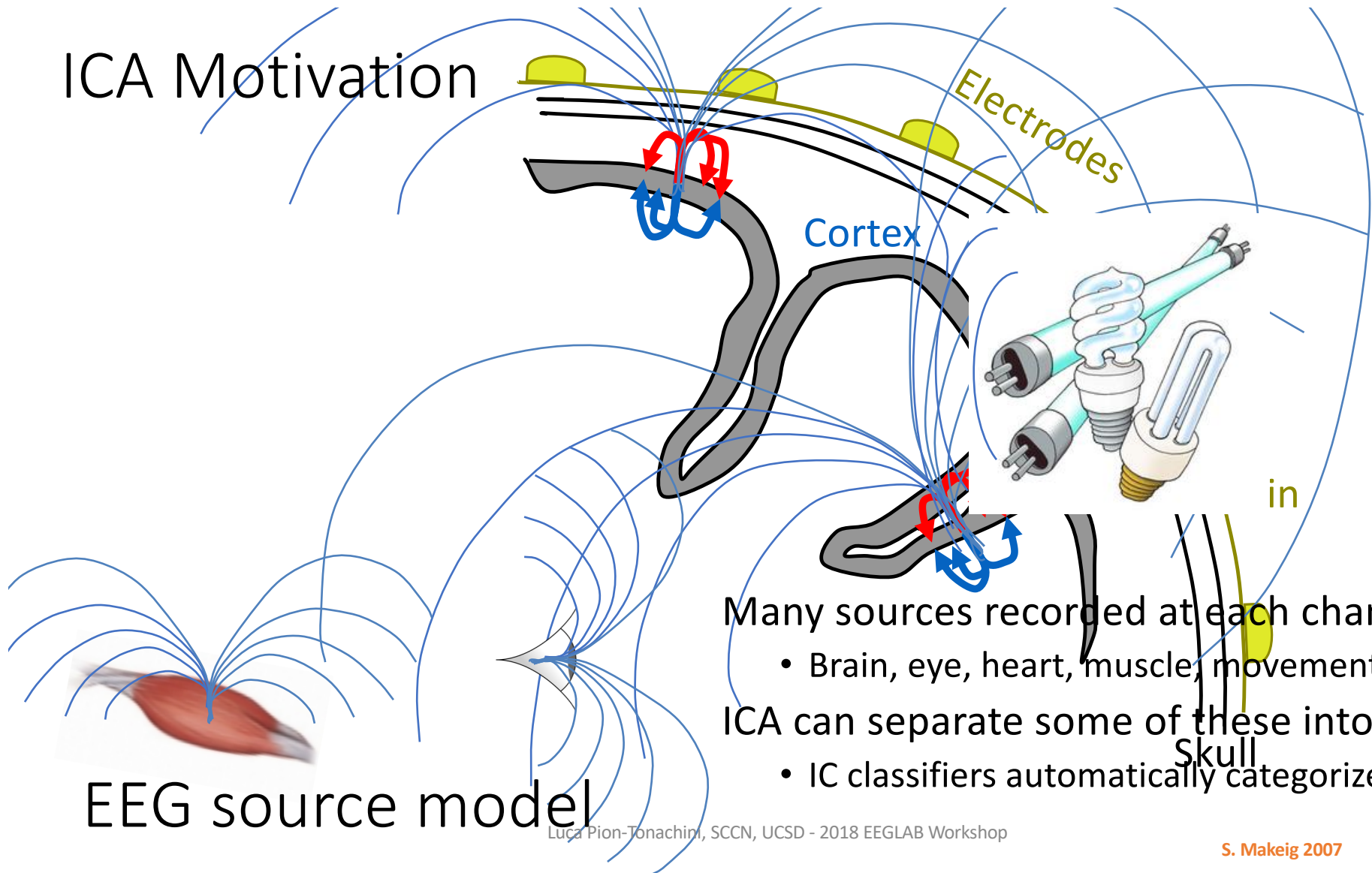
## Online ICA

- Online, Recursive ICA (ORICA)
- Benefits of online ICA

## How these tools can be used together

- Real-Time EEG Source-mapping Toolbox

# ICA Motivation



# Significance of Automated Source Classification

An automated EEG IC classifier answers the question:

**“What is contributing to my recording?”**

And therefore:

**“Which components do I care about?”**

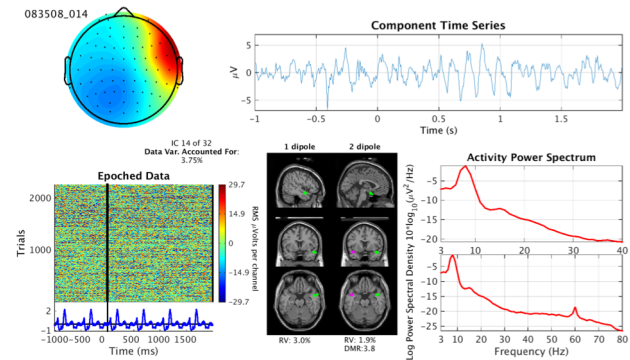
Such a classifier would:

- Facilitate processing and analysis of large-scale EEG studies.
- Provide means of using ICA in automated pipelines.
  - Including real-time applications
- Aid those lacking the skill to manually label EEG components.
  - Labels consistently, independent of mood.

Visit [labeling.ucsd.edu/tutorial/labels](http://labeling.ucsd.edu/tutorial/labels) to learn how to label manually

-OR- attend the Friday 3:50pm talk in Track A “Which IC is which?”

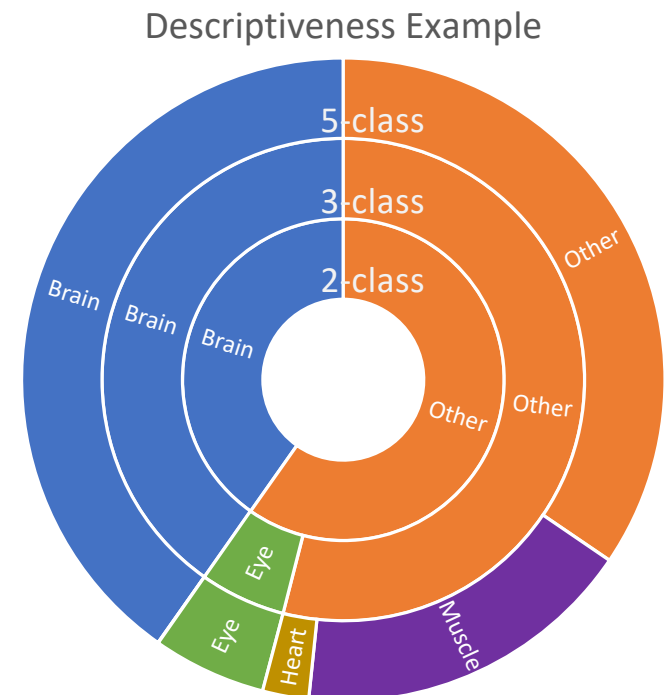
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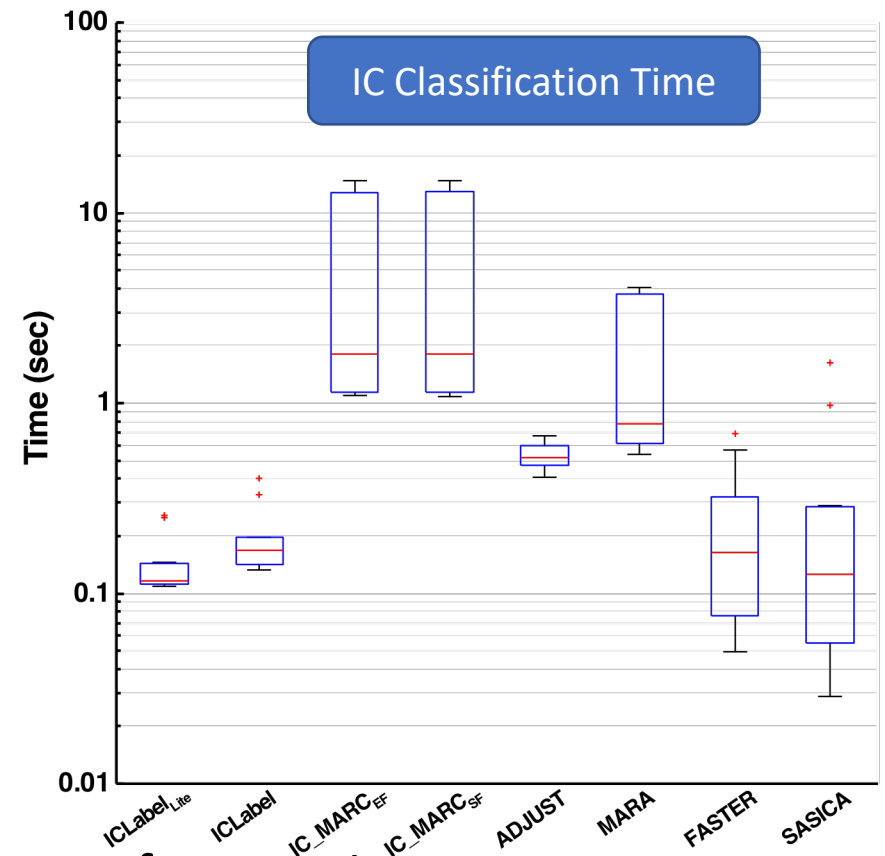
# What makes an IC classifier good?

- Accuracy
  - Can you trust the results?
- Descriptiveness
  - What do the results say about an IC?
- Efficiency
  - How quickly can an IC or a dataset be classified?



# IC Classifiers

Classifiers	IC Categories				
	Brain	Muscle	Eye	Heart	Other
MARA	✓				✓
ADJUST	✓		✓✓✓		✓
FASTER	✓				✓
SASICA	✓				✓
EyeCatch			✓		
IC_MARC	✓	✓	✓✓	✓	✓
ICLabel	✓	✓	✓	✓	✓✓✓



- Multiple ✓s indicate further subdivisions of categories.
- Every method listed here is available as an EEGLAB plugin!

# ICLabel Website and Label Collection

Summary: ask others to help out with labeling EEG components.

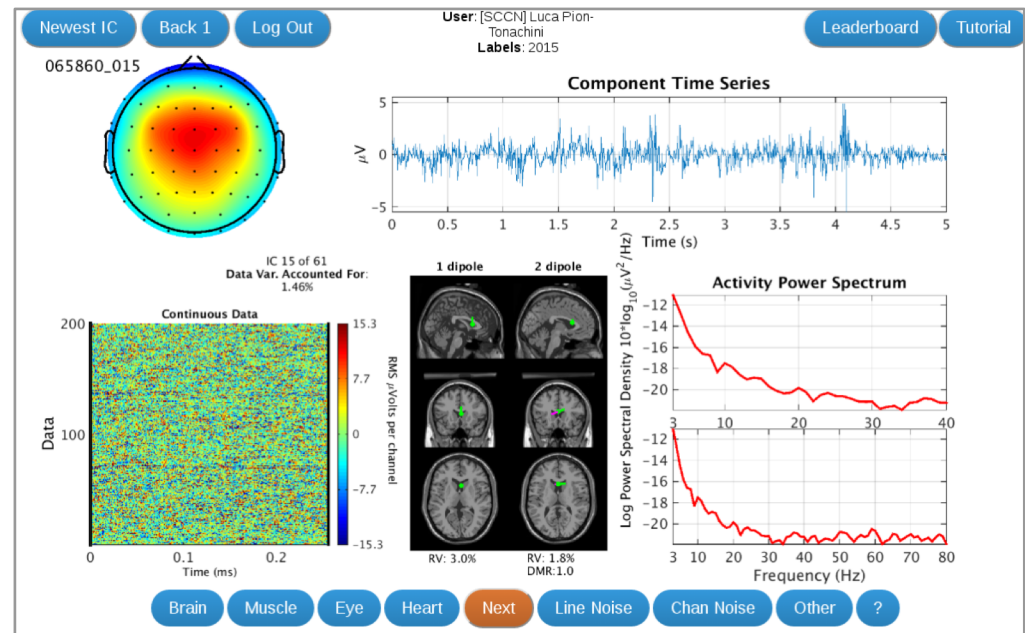
Website: [labeling.ucsd.edu](http://labeling.ucsd.edu)

Have experts from the SCCN and elsewhere label a subset.

Ask the EEGLAB community to help label a larger subset.

**Currently 328 contributing users and 34,000+ submitted labels.**

Has been adapted for educational use as well.

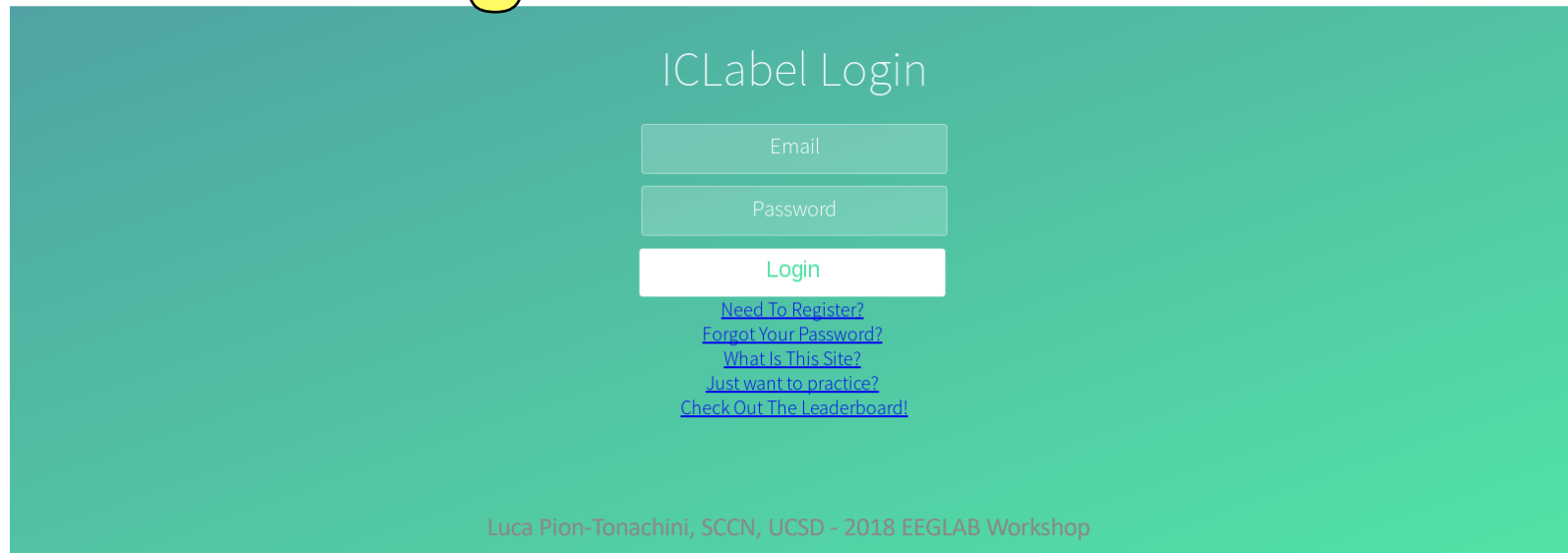


# ICLabel Website

Purpose of the website:

Gather IC labels to accompany our vast collection of datasets.

labeling.ucsd.edu/tutorial

A screenshot of the ICLabel Login page. The page has a teal background. At the top, it says "ICLabel Login". Below this are three input fields: "Email", "Password", and "Login". The "Login" button is highlighted in white. Below the input fields are four links: "Need To Register?", "Forgot Your Password?", "What Is This Site?", and "Just want to practice?". At the bottom, it says "Luca Pion-Tonachini, SCCN, UCSD - 2018 EEGLAB Workshop".

ICLabel Login

Email

Password

Login

[Need To Register?](#)

[Forgot Your Password?](#)

[What Is This Site?](#)

[Just want to practice?](#)

[Check Out The Leaderboard!](#)

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# ICLabel Website - Profile

## Features:

1. Tutorial on IC classification
2. Labeling practice
3. Label collection

## Profile for [SCCN] Luca Pion-Tonachini

[Label EEG Components](#) 

[Tutorial](#) 

[Practice Labeling](#) 

[Leave A Comment](#)

[Log Out](#)

Welcome to your profile. Below you can see some statistics of your activity. To the left, you can navigate to other parts of the website. If you are new to labeling EEG components, I highly recommend reading the tutorial and practicing on some components with feedback. If there is something you think is missing, let me know by leaving a comment (link to the left).

**Number of labels submitted: 2782**

**Time of last submitted label: 2016-11-13 22:48:48**

**Member since: 2016-01-28 01:11:14**

# ICLabel Website - Tutorial

## Tutorial: EEG Independent Component Labeling

[Overview](#)

[Why Help Us?](#)

[How To Label](#)

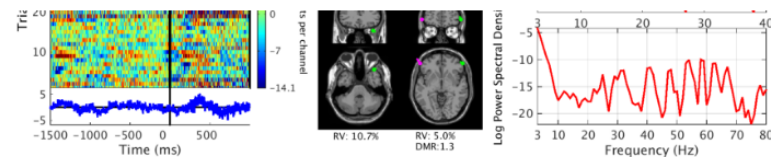
[Telling Components Apart](#)

[Practice Labeling](#)

[Leave A Comment](#)

[Return To Labeling](#)

[Profile](#)



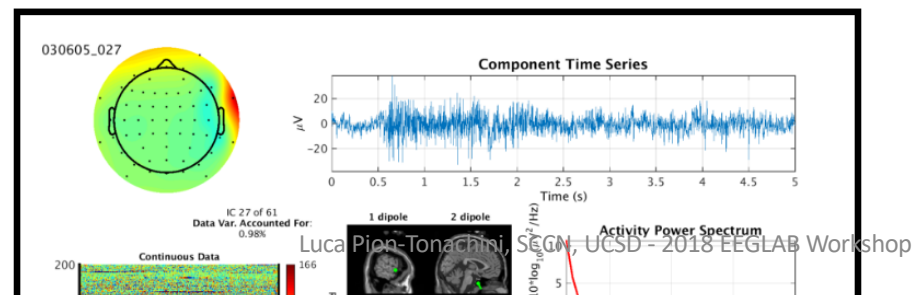
This component captures the effects of horizontal eye movement, although some high frequency power is included from some other source.

### Muscle Component

Muscle components describe the electrical fields generated by muscle activity, known as [electromyography](#) (EMG). Their activations are powerful relative to EEG but motor unit action potentials (the underlying source of EMG) do not synchronize causing most of the power of EMG to be spread out among higher frequencies. Nonetheless, these components can still look dipolar, although they will seem very shallow as they are not localized within the brain. You can tell a shallow dipole by how concentrated its scalp topography is. The more concentrated, the shallower. That isn't to say that all muscle components will be dipolar.

### Summary

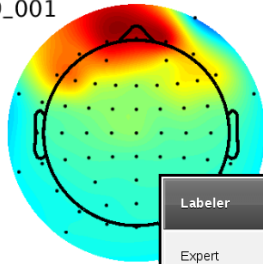
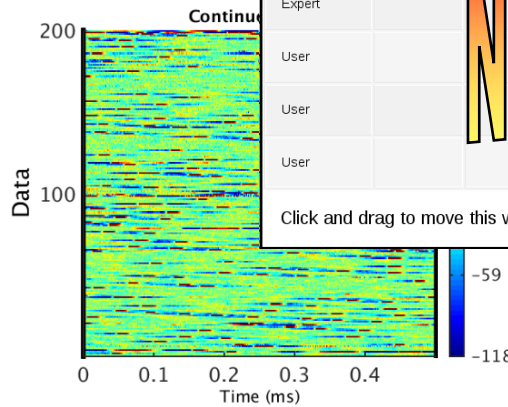
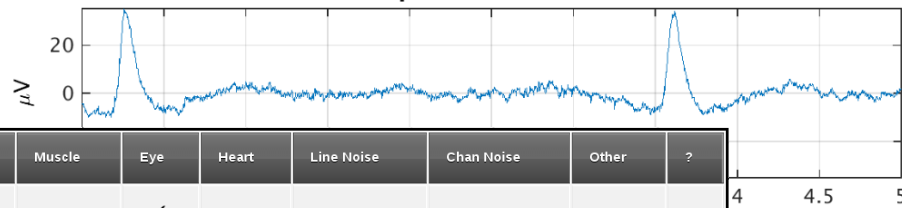
- Power concentrated in higher frequencies (20 Hz and above)
- Can still be dipolar, but will be located outside the skull



# ICLabel Website – Practice Labeling

[Leaderboard](#)[Tutorial](#)[Profile](#)

012599\_001

**Component Time Series**

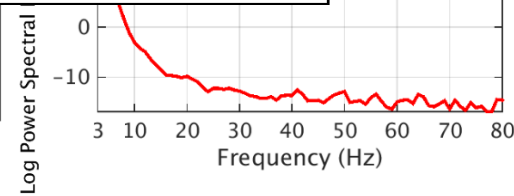
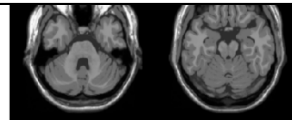
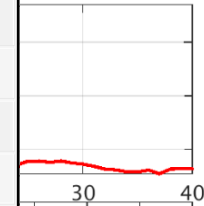
Continu

Labeler	Brain	Muscle	Eye	Heart	Line Noise	Chan Noise	Other	?
Expert			✓					
Expert			✓					
Expert			✓					
User								
User								
User								

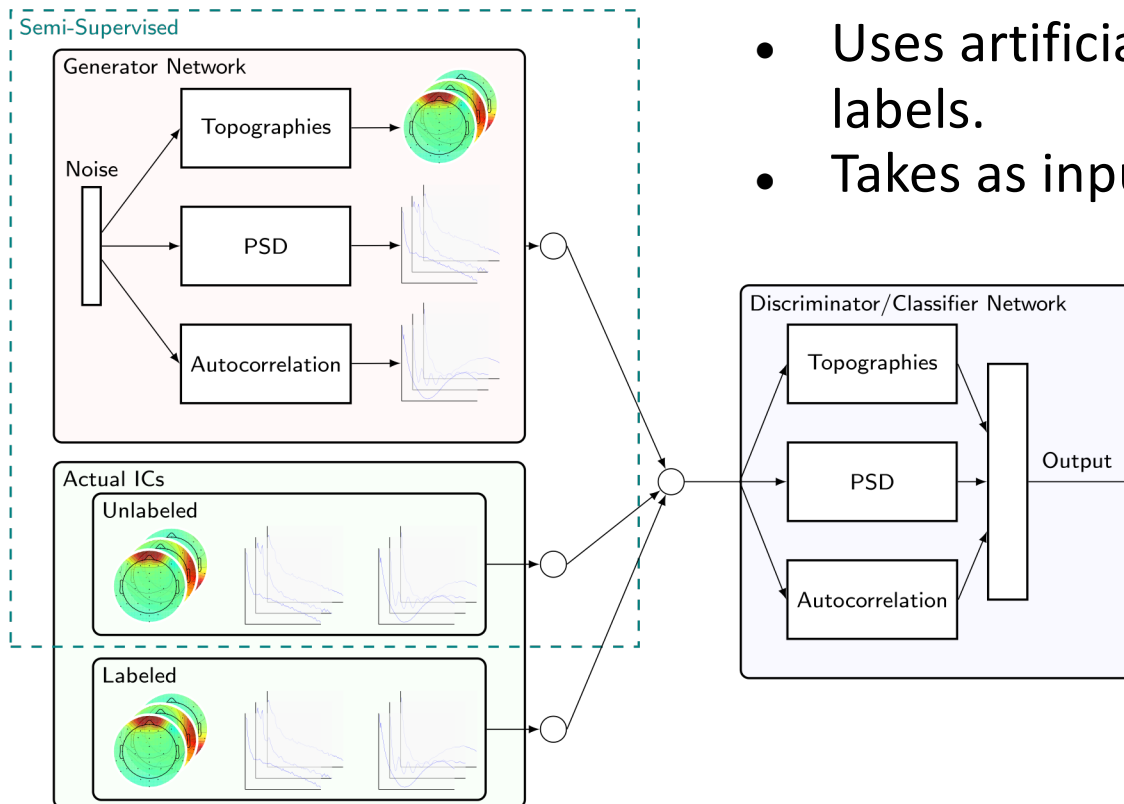
Click and drag to move this window.

[Next](#) [Comment](#)

No Login Required

**Spectrum**[Brain](#)[Muscle](#)[Eye](#)[Heart](#)[Submit](#)[Line Noise](#)[Chan Noise](#)[Other](#)[?](#)

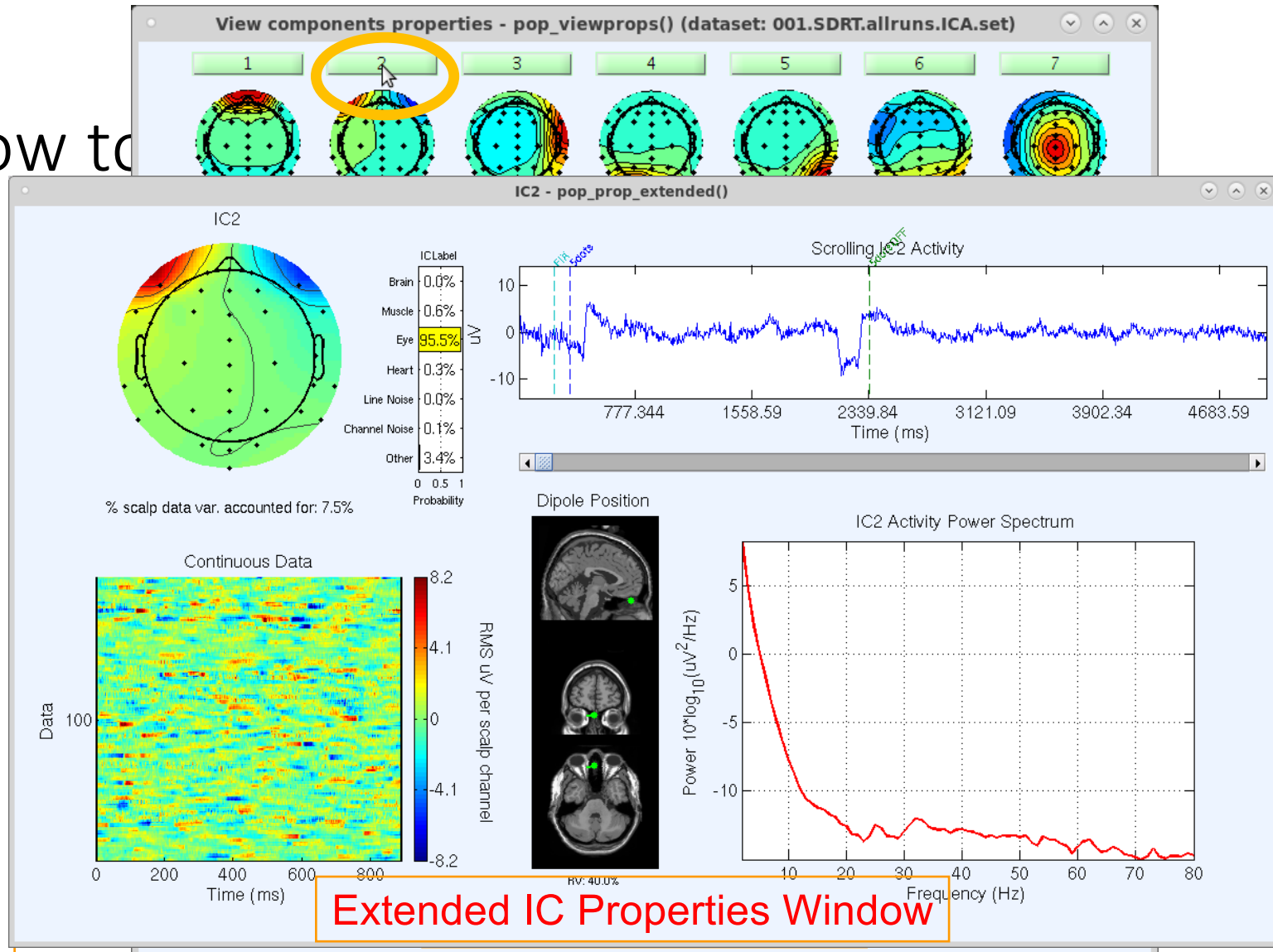
# ICLabel Structure



- Uses artificial neural networks to generate labels.
- Takes as input:
  - Scalp topography
  - Power spectral density
  - Autocorrelation function



How to



# Outline

## Automated Source Classification

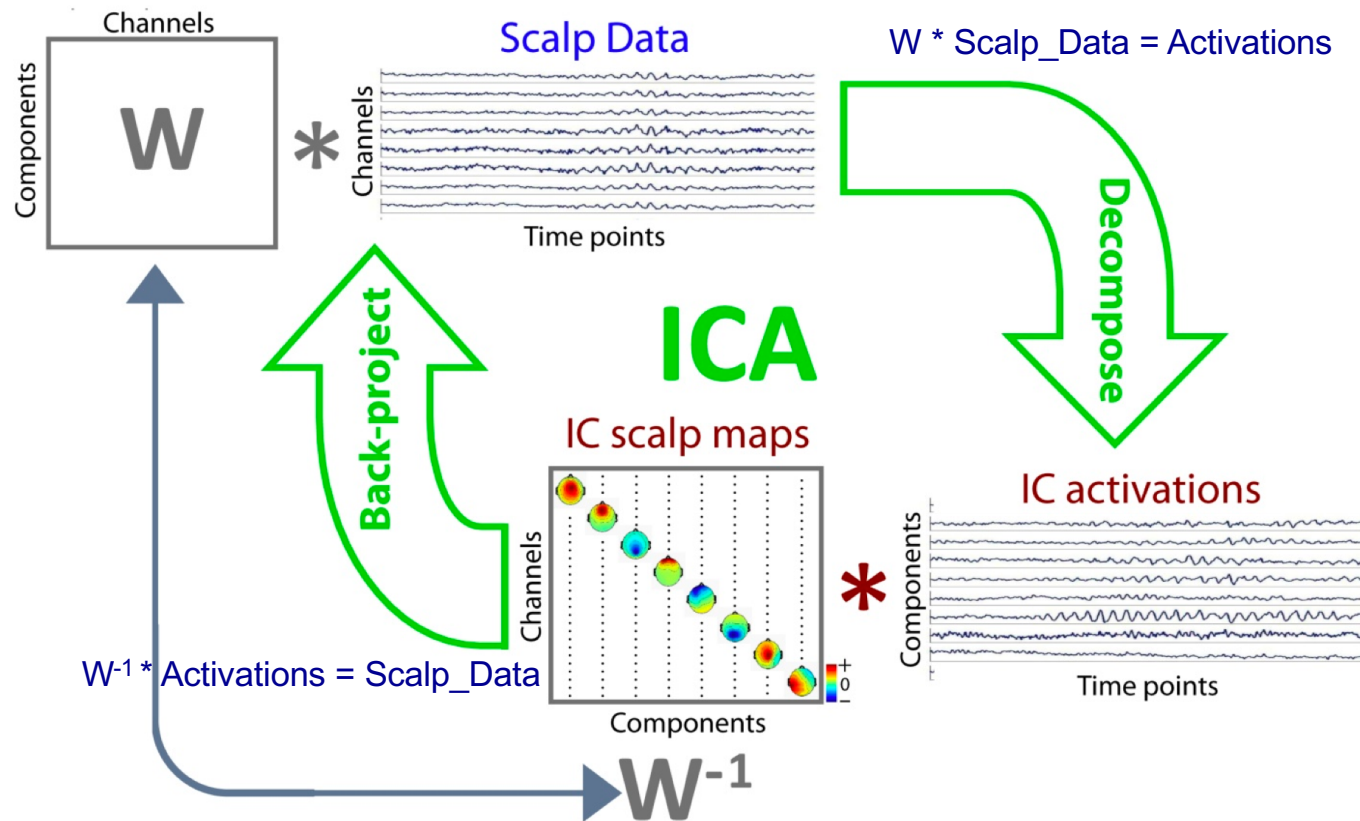
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## Online ICA

- Comparison to offline ICA
- Benefits of online ICA
- Some use cases

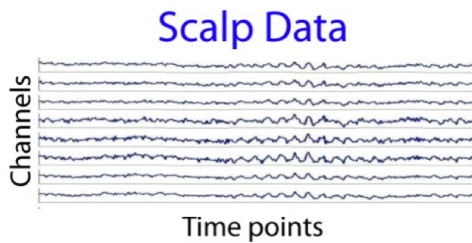
## How these tools can be used together

# Independent Component Analysis (ICA) is a linear data decomposition method



Assumes sources mixture is linear, instantaneous, and stationary.

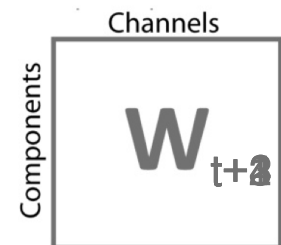
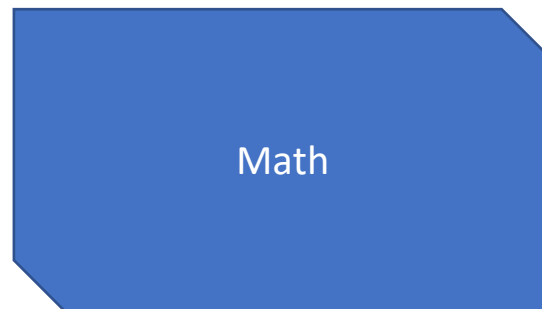
# Online Recursive ICA (ORICA)



ORICA performs near-real-time ICA through online, recursive updates.

- Can handle streaming data in real-time.
- Optimizes same metric as offline infomax ICA
- Provides a non-stationary solution (more on this in the next talk)

## ORICA



# Benefits of online ICA

- Real-time source analysis
- Nonstationary analysis
- Real-time ICA-based cleaning
  - This also requires an IC classifier...

# Outline

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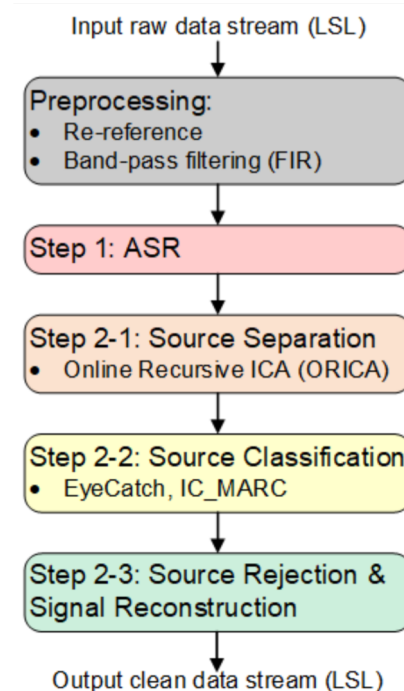
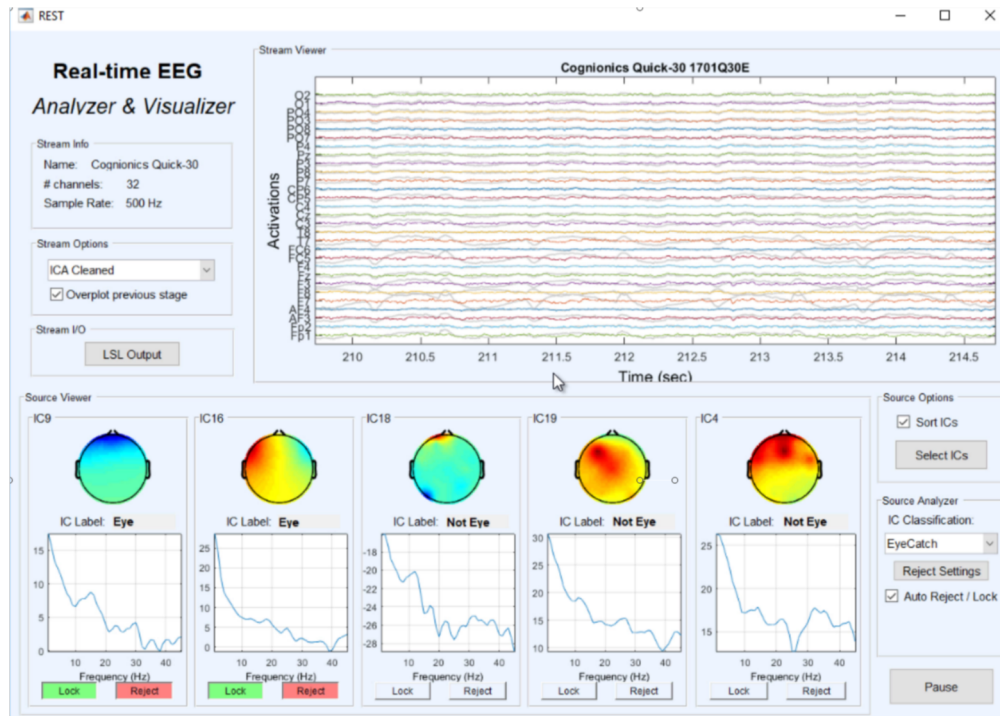
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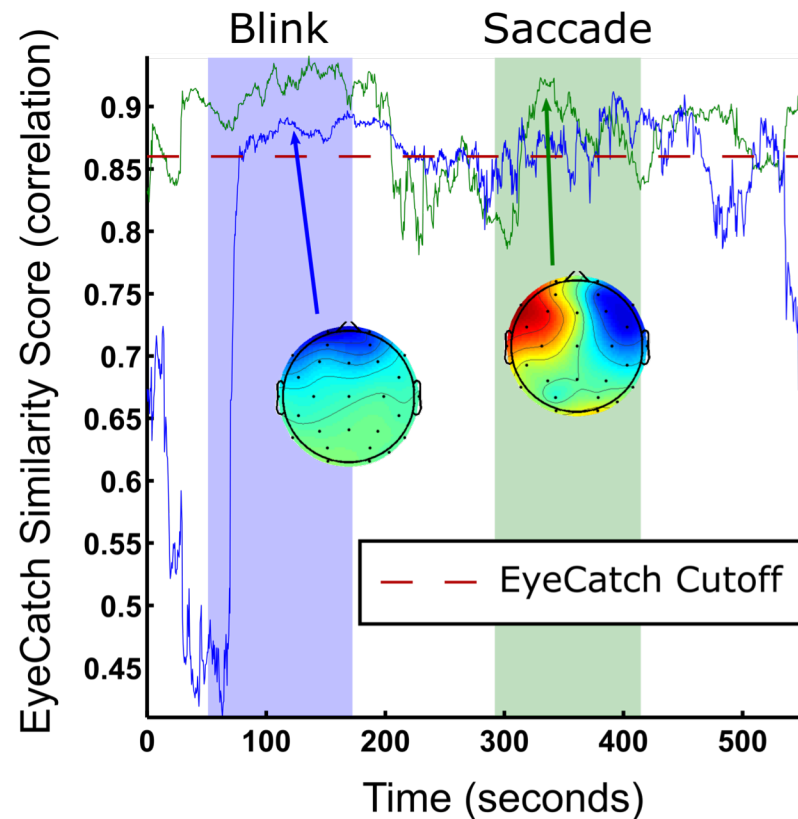
# REST - [github.com/goodshawn12/REST](https://github.com/goodshawn12/REST)



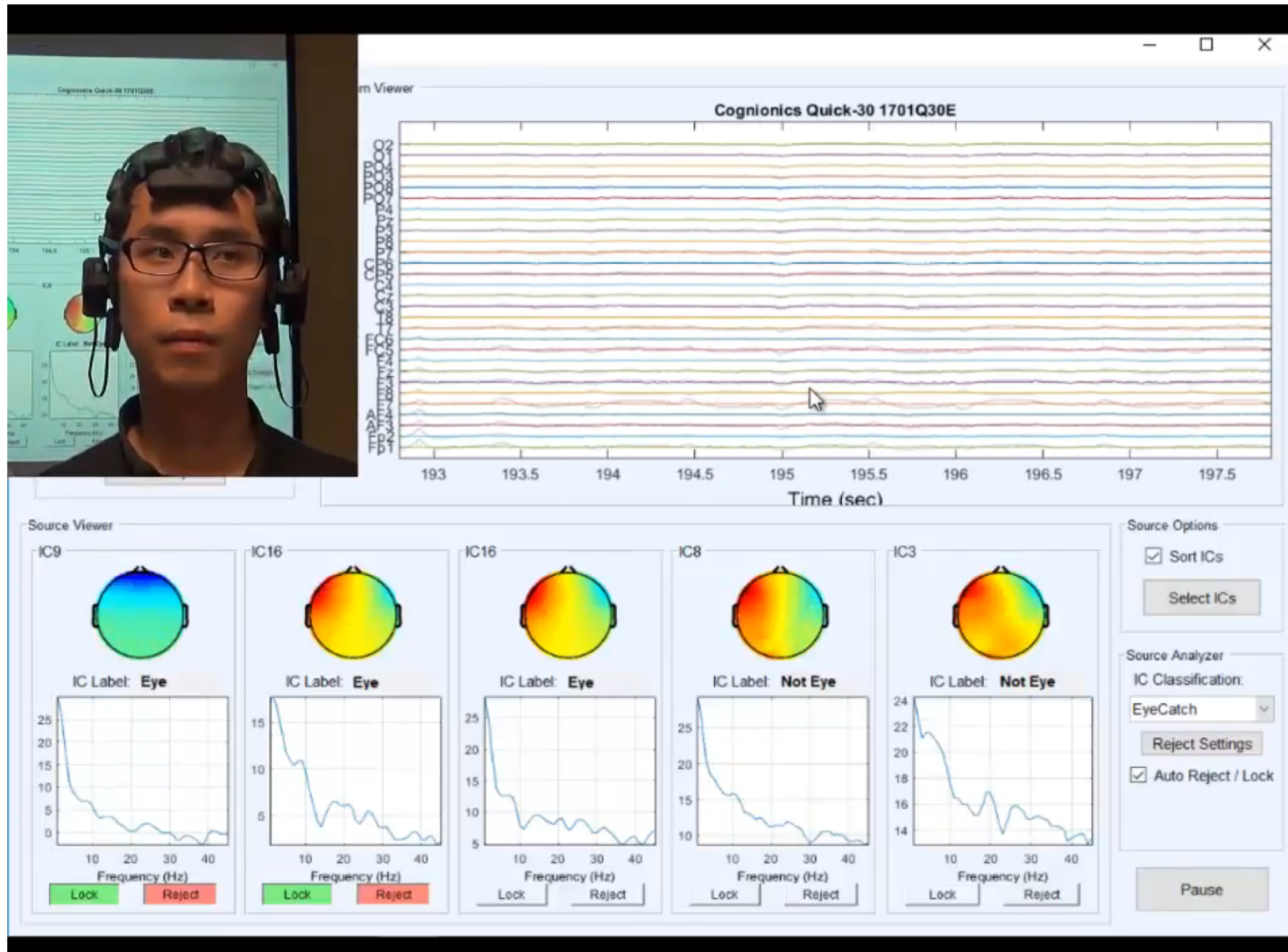
- Fully automated and largely customizable
- LabStreamingLayer stream as input – LabStreamingLayer streams as output(s)

# Real-time IC classification using EyeCatch

- ORICA separates eye-blink and saccade activity.
- Blink activity stably removed
- Saccade activity removed, but unstable







# How to use REST

- Download REST from [github.com/goodshawn12/REST](https://github.com/goodshawn12/REST)
- Run “test\_script.m” which will:
  - Initialize BCILAB environment
  - Start an LSL stream broadcasting prerecorded EEG data
  - Start REST and capture the LSL stream
  - Begin filtering, cleaning (ASR), and decomposing (ORICA) the streaming data
- Real-time ICA rejection can be activated by clicking the “Auto Reject / Lock” checkbox.
- Output streams of any stage in the pipeline can created easily.

## Try ICLabel

- Download the ICLabel and viewprops plugins via the EEGLAB plugin manager.
- The ICLabel plugin currently only has the beta classifier but will be updated shortly.

## Try REST

- Download from [github.com/goodshawn12/REST](https://github.com/goodshawn12/REST)
- Easily and invisibly integrates into existing experiments using LSL.
- REST is still being actively developed.

Thank you!