Dictionary Learning on Epileptic ECoG Waveforms

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Introduction

- The purpose of this research is to find short waveforms that reappear frequently in brain waves measured by ECoG.

- The set of reappearing waveforms is a dictionary.

- A signal is composed of atoms, which are waveforms in the dictionary, at specific times and scales.

- The waveforms were found using dictionary learning on a sample of the ECoG readings.

- In the data set, there are two conditions: preictal (before a seizure) and interictal (between seizures).
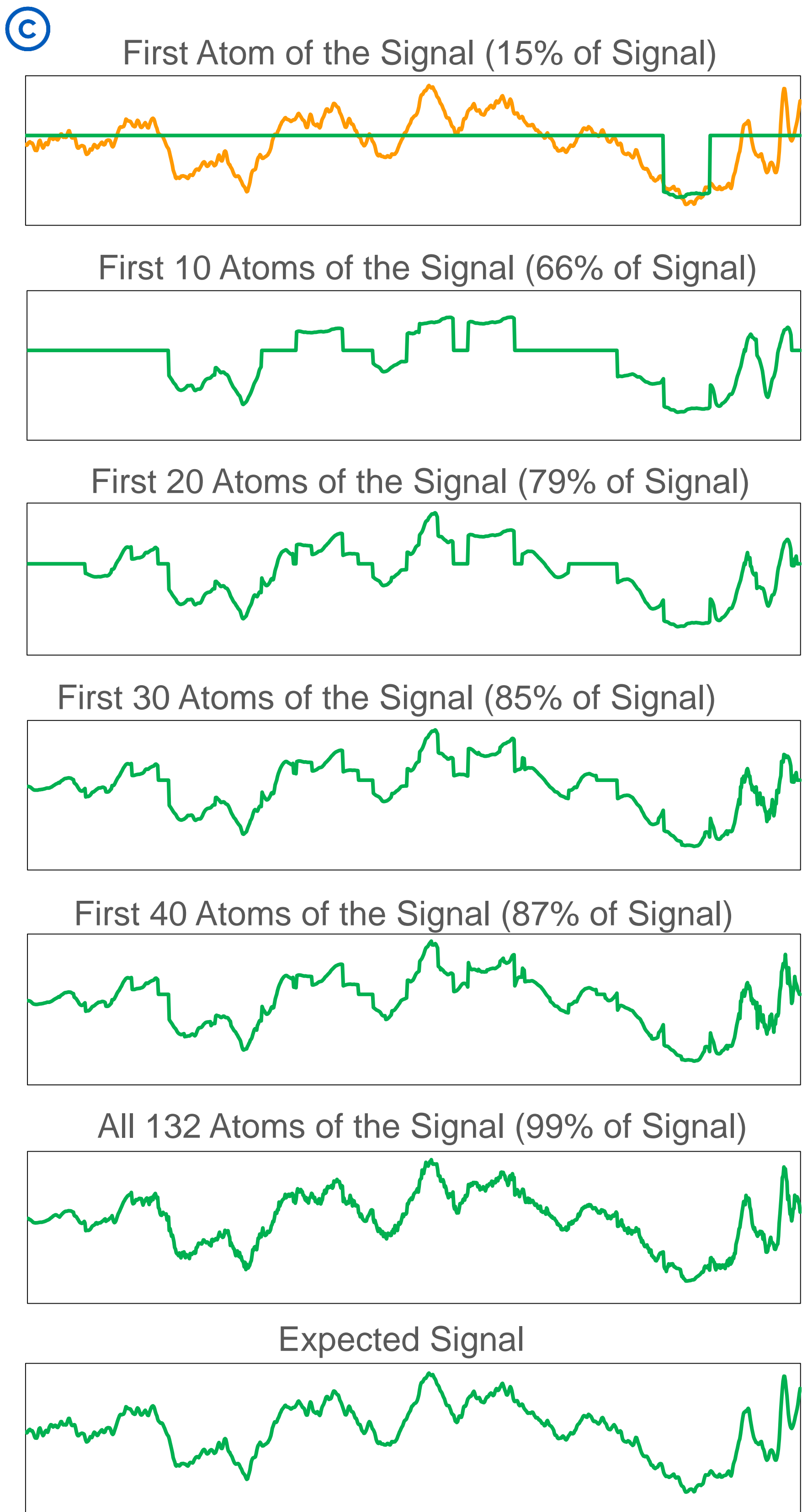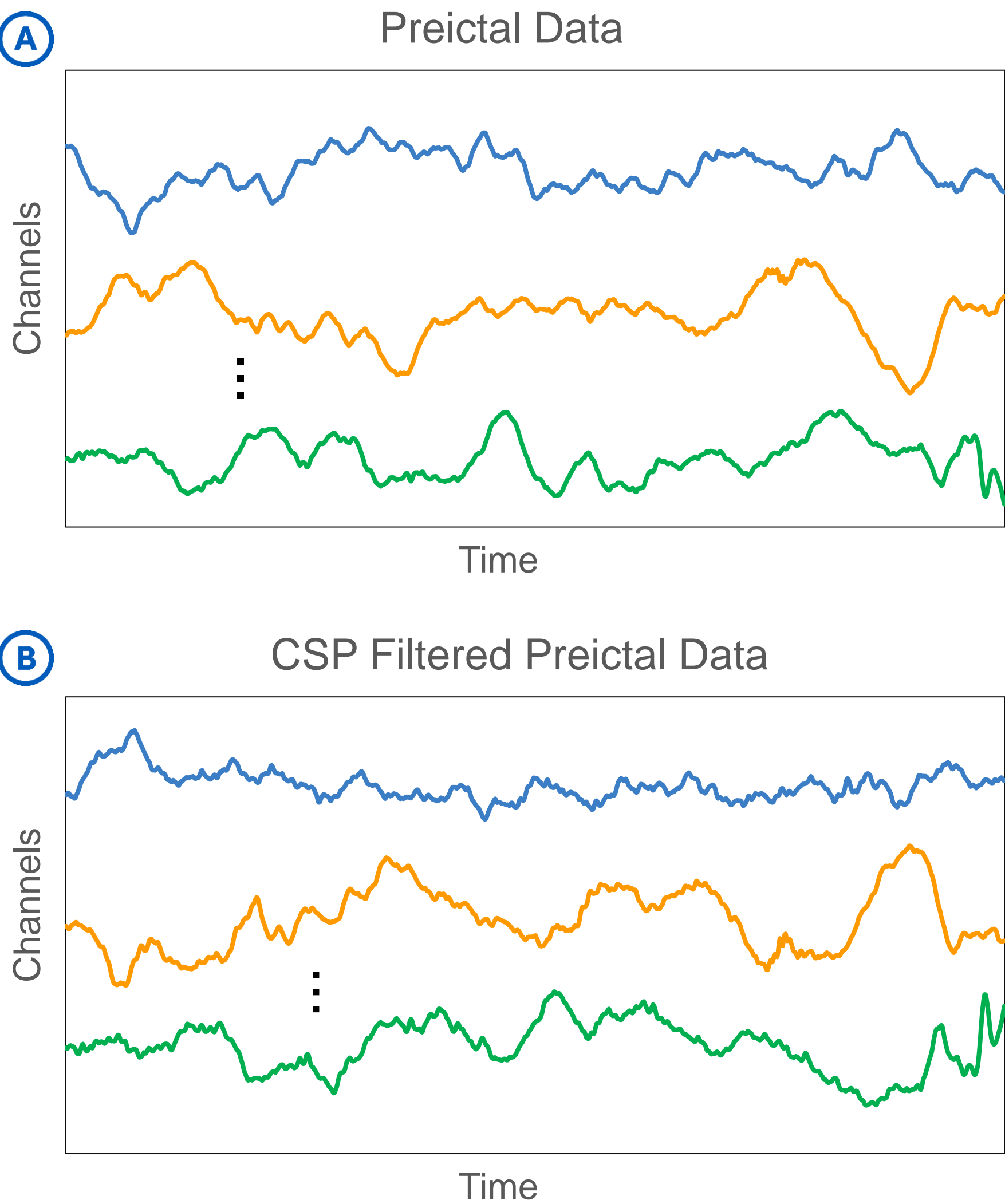
Objectives

- Are there atoms that are distinctively used in one type of ECoG and not the other?

- Will alphaCSC find similar results to other dictionary learning algorithms?

Methods

- I used alphaCSC, a dictionary learning library, to generate 64 atoms from multiple preictal waveforms.

- With these atoms, I applied matching pursuit to attempt reconstruct signals using only the atoms.

- I performed a χ^2 test to find the atoms that were unique to either preictal or interictal signals. These atoms mostly occurred in one type of ECoG, not both.

Data Analysis

A. Each signal has multiple channels to represent each ECoG signal.

B. A common spatial pattern (CSP) filter is applied to maximize the energy of preictal signals.

C. A matching pursuit algorithm using the atoms generated from alphaCSC, attempted to recreate the green signal in [Figure B]. Each plot shows the recreated signal with more atoms and how close it is to the actual signal.

A Preictal Data

Channels / Time

B CSP Filtered Preictal Data

Channels / Time

C

First Atom of the Signal (15% of Signal)

First 10 Atoms of the Signal (66% of Signal)

First 20 Atoms of the Signal (79% of Signal)

First 30 Atoms of the Signal (85% of Signal)

First 40 Atoms of the Signal (87% of Signal)

All 132 Atoms of the Signal (99% of Signal)

Expected Signal

Results

- The χ^2 test found several atoms that were much more prevalent in one condition than the other.

- The top 6 atoms are shown in [Figure D]. The small graphs on the side show how often each waveform appears in preictal (orange) signals and interictal (blue) signals.

D Top 6 Unique Atoms
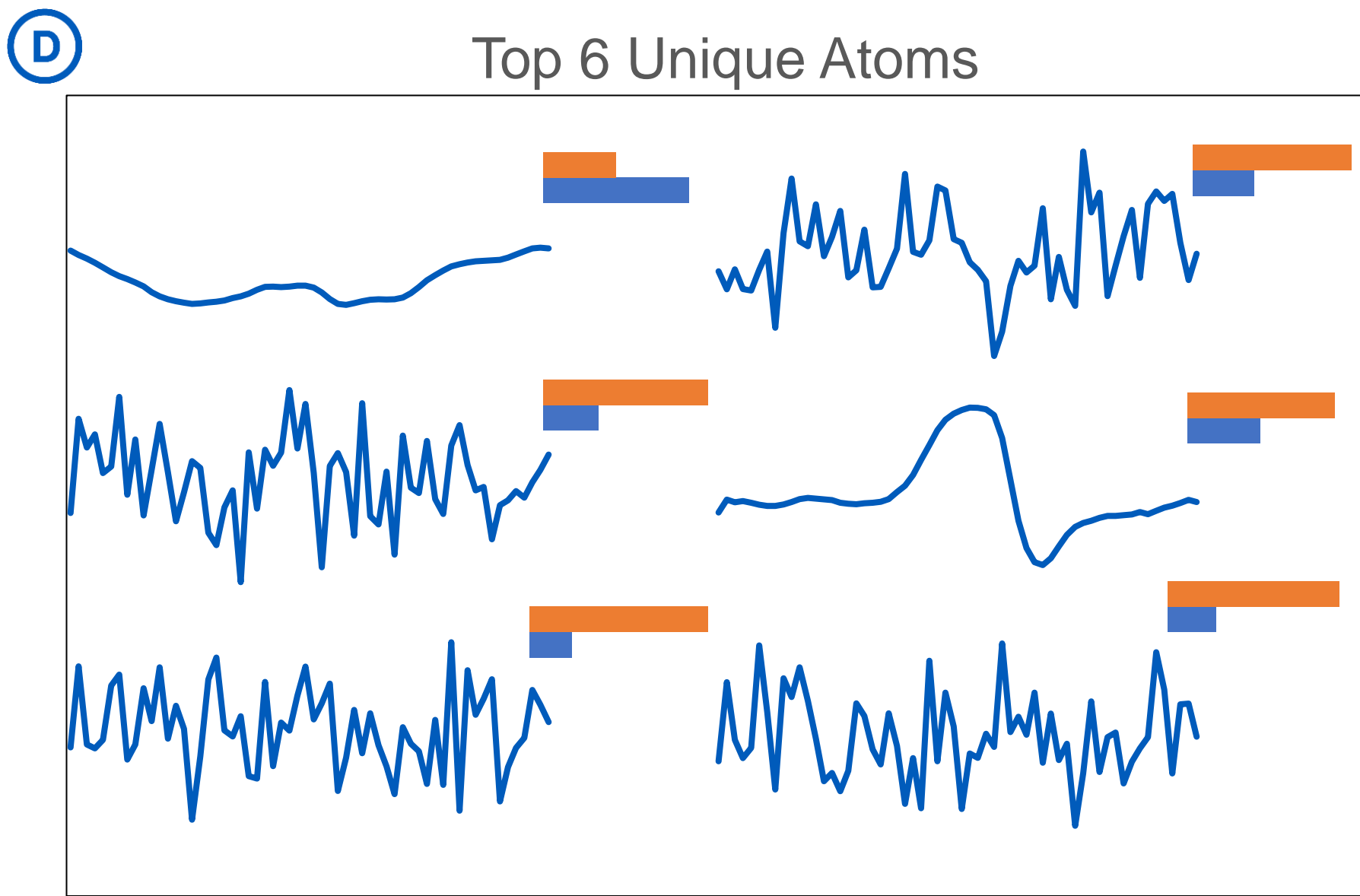
Future Goals

- I am going to compare the dictionary found using alphaCSC to a dictionary generated with another dictionary learning method.

- The goal is to find similar atoms in both dictionaries in order to find the best waveforms to represent the data.