Reconstructing a Proto-Bat Call

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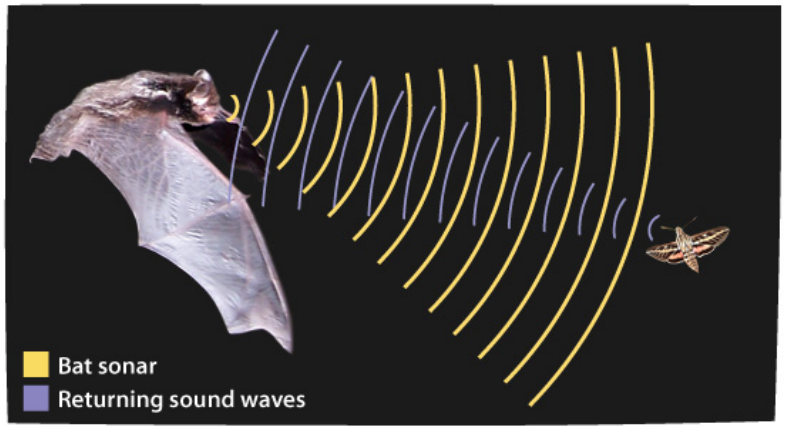
Why is a Proto-Bat Call of Interest?

Second most Speciose order of Mammals

Arguably the most Ecologically Diverse



Nocturnal

Echolocate

Flight

[1] Image: https://askabiologist.asu.edu/echolocation

The Ability to Echolocate

Understanding the evolution of Echolocation

Extant Bat Calls

Guilds

Ecological Factors

Evolutionary Factors

Family Resemblance

[2]Image: Guardian 2008

Previous Research

Characteristics of a Proto-Bat

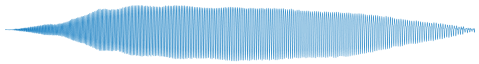
- Slow and manouvreable flier
- Opportunistic and omnivorous diet
- Perch Hunting Foraging strategy
- Forest habitat

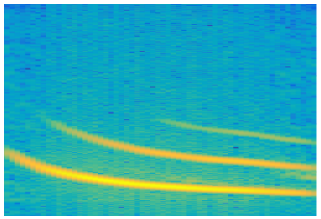
Features Used

- Bandwidth
- Call Duration
- Characteristic Frequency
- Dominant Slope
- Maximum Frequency
- Minimum Frequency
- Peak Frequency
- Total Slope
- Peak Harmonic

[3] The evolution of echolocation in bats: a comparative approach - Maltby

Statistical Methodology





Extant Bat Calls

Time-Frequency Representation

1816 calls
449 individuals
22 Species

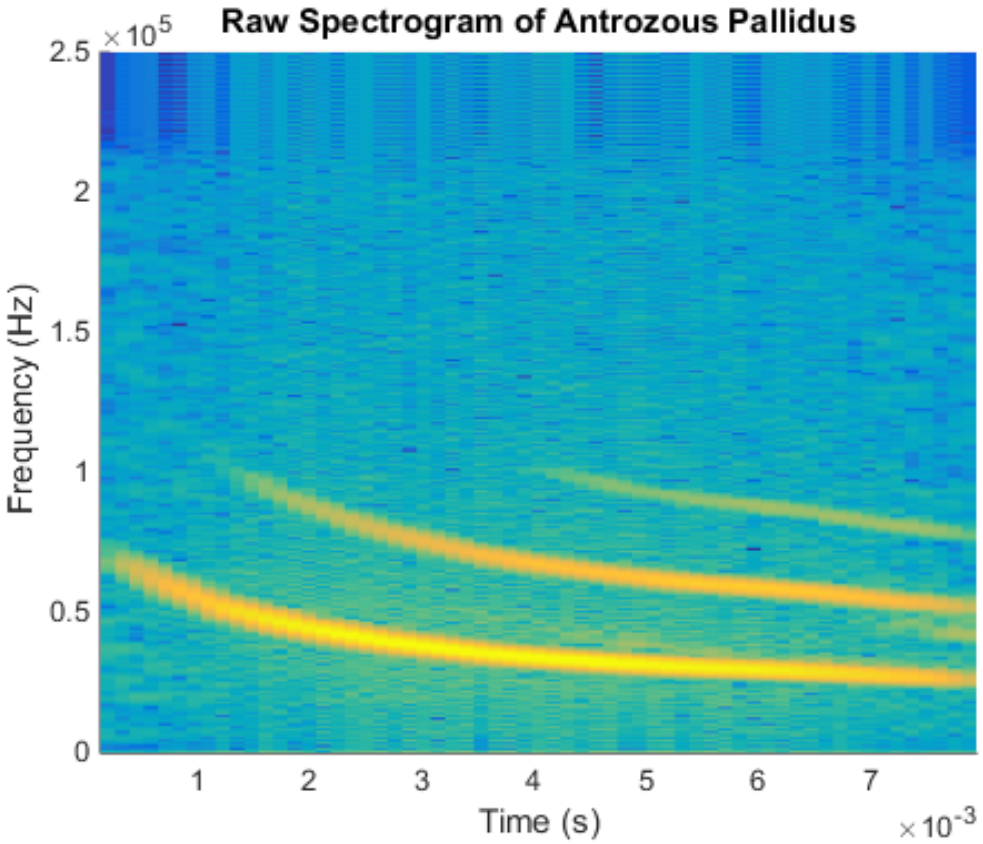
Principle Components Analysis

Gaussian Regression on Phylogenies

Ancestral Call

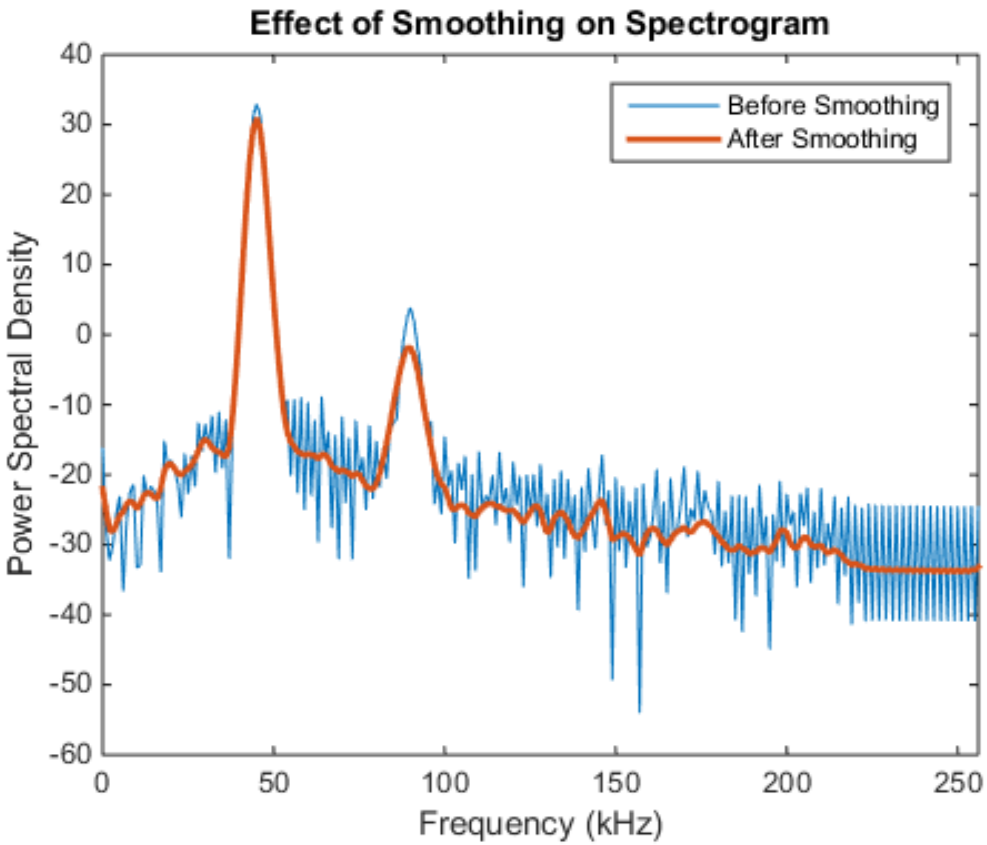
[4] Data Available at http://www.engage-project.org

Time-Frequency Representation - Spectrogram



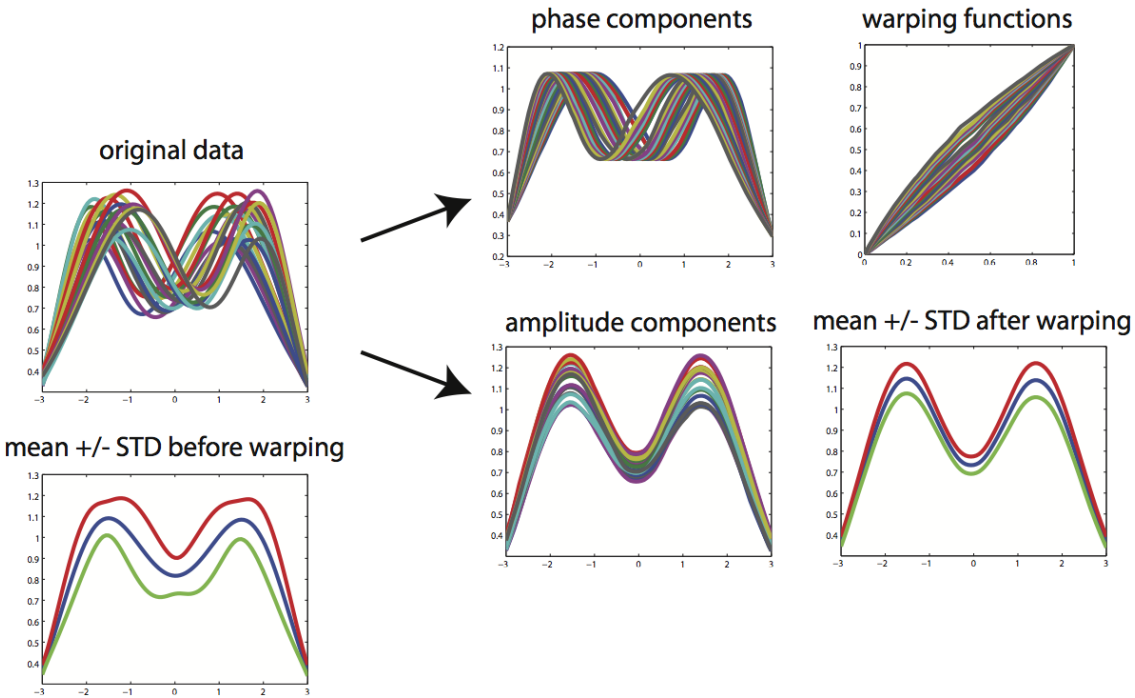
- Power Spectral Density of the Short-Time Fourier Transform of the Call.
- Spectrogram = Generating function + Noise

Time-Frequency Representation - Smoothing



- Applied over the whole surface
- Reduces the effect of noise on the surface.

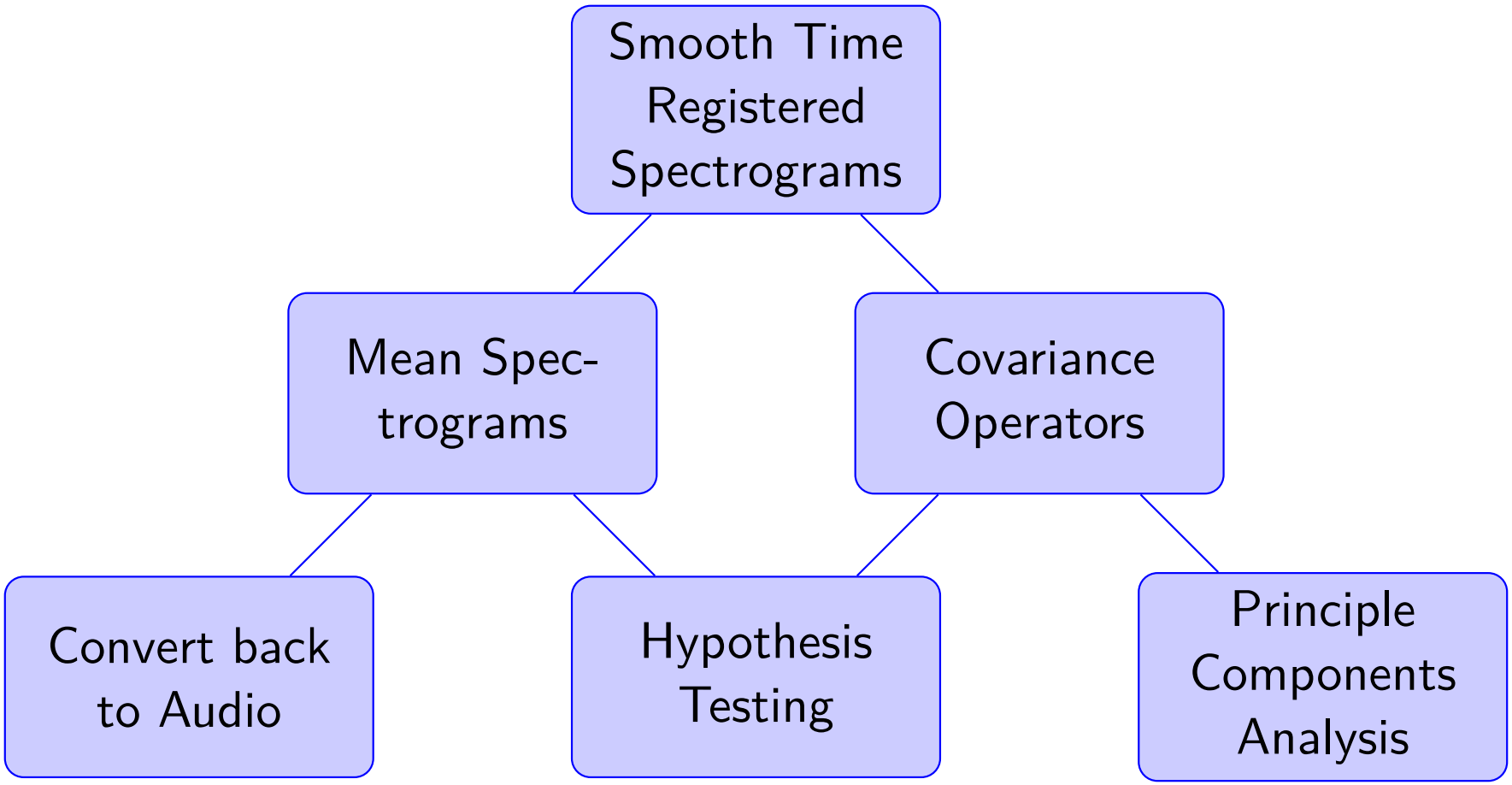
Time-Frequency Representation - Time Registration



- Rescales all the calls onto the same time scale.
- Seperates phase and amplitude analysis.

[4] Image: http://ssamg.stat.fsu.edu/images/projects/registration-functional-data/fig1.png

Time-Frequency Representation



Why wouldn't ye want to know what the first bat sounded like? Sure any boy that sprouts wings and uses sound to see is a boss. If we figure out how they pulled it off maybe we could manage something similar ourselves. Sounds good right... right?

Plus there's loads of bats, all doing their own mad shit and even when they're up to similar craic, they all have different ways of doing it. So they potentially had to figure a lot of it out by evolution.

Thing is, the fossils of the old bats we dig up are not telling us much about the whole seeing with sound thing developing. So we gotta come at it from a different angle

So anyway, Alla Maltby copped that there was a gap in the research here and decided to do her PhD on building a bat supertree and trying to assess the role of evolution in the various bat echo location calls.
Her results suggested that the proto bat was...
Her analysis took features from a time-frequency representation (spectrogram) and assessed these features by comparative analysis... I am trying to do something similar but instead of extracting features and using these as a starting point I'll just use the spectrogram. Hopefully my results will corroborate hers.

Methods

start with the call .... time frequency representation - Spectrogram do some shit with this to make them comparable ... PCA - identify sources of variation (components), different representations of the data, treat these as traits ... Gaussian tree constraints - see if variance of these traits is consistent with a tree structure, Alanna's super tree will be super handy i hope .. Gaussian Process Regression on traits .. Representation of Call of Proto-Bat, ideally the same as alannas.

Thedata set im using is publicly available..
Hopefully I'll get stuck into the EchoBank data once I've developed the statistical techniques.

So far been slogging through detail on the time freq banter. Speectrogram ... Smooth - functional data .. Time registration - seperates the phase and amplitude analysis of the surface, allow comparison of amplitudes at different frequencies .. Mean Spectrograms for each species (sound) .. Covariance operators (seperability), leads in to PCA. Hypothesis testing are mean spectrograms all the same. Are all the covariance operators the same?

Results

Mean Spectrograms, Covariance operators, Hypothesis testing results, Sounds?

Discussion

Been throwing a few shapes, making some moves, picked up a few bits and pieces, hope that if I plough on I can produce some good shit that agrees with what is out there currently and potentially contribute to a frame work for analysing bioacoustic data.