

Classifying Nocturnal Flight Calls using Non-Negative Matrix Factorization (PRISM 2022)

Caitlin Wiley

A dark blue diagonal gradient shape that starts from the bottom left corner and extends towards the top right corner, covering the lower half of the slide.

What is a Nocturnal Flight Call?

A NFC is how birds communicate to one another when travelling at night. The short sounds sometimes go unnoticed to the human ear.



American Redstart NFC



What is Non-Negative Matrix Factorization?

NMF is a process that factors a matrix of non-negative numbers into smaller matrices. From here NFCs are classified based on what can be extracted from the image.

$$\begin{matrix} \text{W} \\ \left[\begin{array}{|c|c|} \hline & \\ \hline & \\ \hline & \\ \hline & \\ \hline \end{array} \right] \end{matrix} \times \begin{matrix} \text{H} \\ \left[\begin{array}{|c|c|c|c|c|} \hline & & & & \\ \hline & & & & \\ \hline & & & & \\ \hline & & & & \\ \hline \end{array} \right] \end{matrix} \approx \begin{matrix} \text{V} \\ \left[\begin{array}{|c|c|c|c|c|} \hline & & & & \\ \hline & & & & \\ \hline & & & & \\ \hline & & & & \\ \hline \end{array} \right] \end{matrix}$$

Dataset and Testing

- Five Warbler and Two Sparrow species.
- The Data was split 40-60.
 - 40% being what was tested.
 - 60% what was used as a “training” set.

Project Management

The screenshot shows a GitHub repository page for 'jdyrnacek / MAFR'. The repository is public and has 1 star, 3 watchers, and 1 fork. The main branch is 'main'. The repository contains several files and folders, including 'doc', 'old', 'src', 'tests', 'tools', '.gitignore', and 'README.md'. The README.md file is open, showing the title 'MAFR' and the description 'Magnificent Frigatebird -- NFC recognition using NMF'. The repository has 226 commits and was last updated on July 5th. The page also shows navigation links for Code, Issues, Pull requests, Actions, Projects, Wiki, Security, and Insights. The right sidebar contains sections for About, Releases, Packages, and Contributors.

Search or jump to... Pull requests Issues Codespaces Marketplace Explore

jdyrnacek / MAFR Public

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Code Issues Pull requests Actions Projects Wiki Security Insights

main 1 branch 0 tags Go to file Add file Code

EddyJohn51 added tools for reconstructing spectrograms and patterns 9b9cec5 on Jul 5 226 commits

doc	Update workflow.md	5 months ago
old	updated simple	6 months ago
src	added tools for reconstructing spectrograms and patterns	5 months ago
tests	Rename testMAFR.py to tests/testMAFR.py	6 months ago
tools	Updated tools	5 months ago
.gitignore	Initial commit	8 months ago
README.md	Update README.md	8 months ago

README.md

MAFR

Magnificent Frigatebird -- NFC recognition using NMF

About

NFC recognition with NMF

- Readme
- 1 star
- 3 watching
- 1 fork

Releases

No releases published
[Create a new release](#)

Packages

No packages published
[Publish your first package](#)

Contributors 3

EddyJohn51 John Eddy

My Role:

I worked with students participating in the Summer 2022 PRISM program lead by Dr. Julian Dymacek.

I worked for approximately 4-6 weeks over the summer while I was working in Admissions part time.

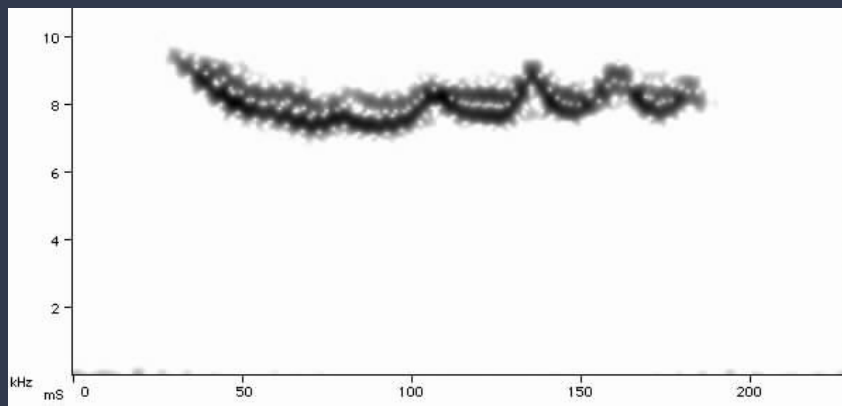
My job was to write some side tools for the project and research topics that were relevant to what we were working on.

What I did.

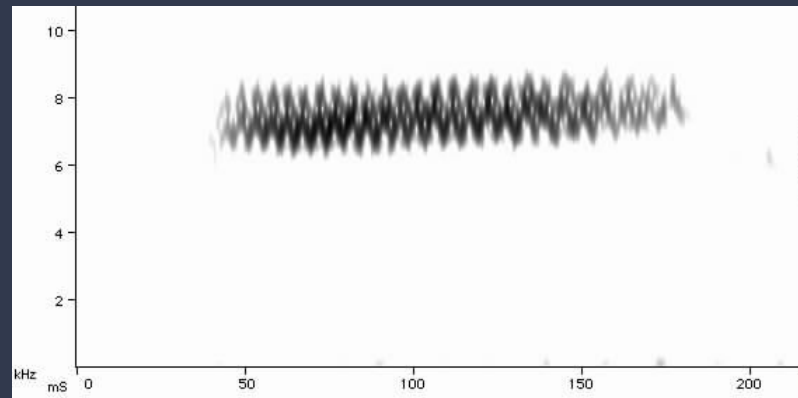
- Analyzed nocturnal flight calls to identify unique patterns.
- Pair programmed in HTML to examine nocturnal flight calls.
- Designed a tester program.
- Designed a program that determined the highest accuracy between a image and a .nmf.
- Auto Eigen program for distributed testing.
- Javascript program.

Analyzing NFC's

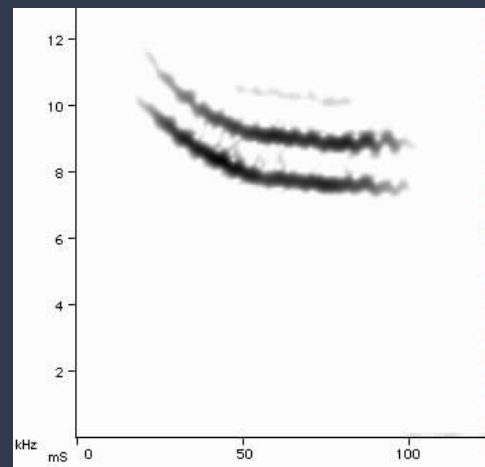
White-throated Sparrow



Swamp Sparrow



Savannah Sparrow



HTML Interface

This interface was pair programmed with a PRISM student.

The purpose of this program:

- Help Identify where the best place to cut the image at.
- Identify the best way to extract the NFC from the image without excessive noise.

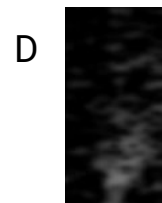
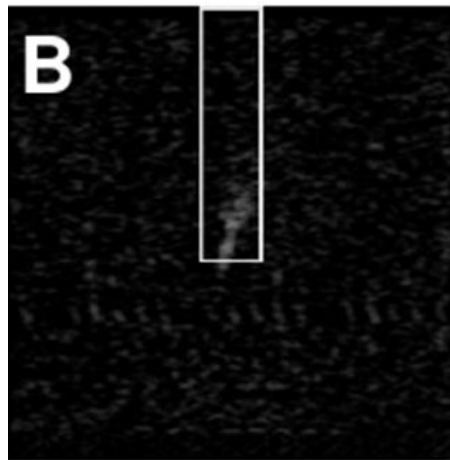
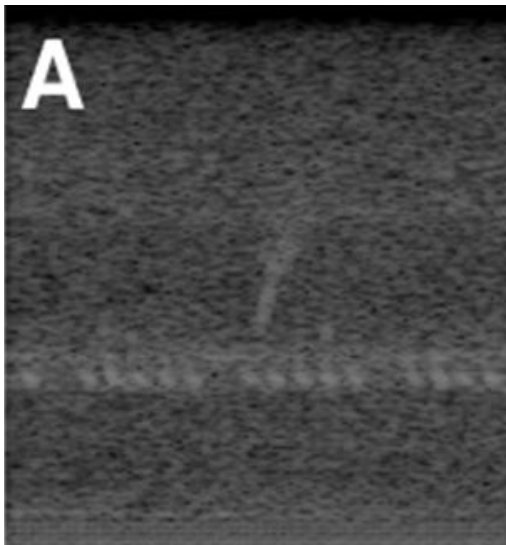


Image Results

Tester Program

Overall this program was to ensure that the image was being correctly translated to a matrix. This was also to confirm that we were passing the correct layout to functions.

- Opened and image file.
- Converted to a matrix.
- Did some conversions to an array for each “line”.
- Wrote the output to an output file.

Written to determine the highest coefficients/percentages between a NFC and a tester image.

- Converted and Image to a matrix.
- Took the pseudo inverse of the matrix.
- Multiplied with the NFC to produce the coefficients.
- Extracted the coefficients.
- Produced a tuple with the value and a label.
- Sorted so the highest coefficient would be first.

Highest Accuracy Program

Auto Eigen

This program allowed us to exhaust the search space by running on multiple machines in the lab.

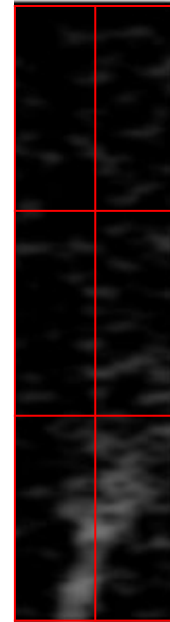
The results were then placed into a csv file where we could examine the output

Auto Eigen Results

Patterns	Width	Removed	Accuracy
20	36	100	0.754
20	36	101	0.756
20	36	102	0.787
20	36	103	0.764
20	36	104	0.768
20	36	105	0.741
20	36	106	0.766
20	36	107	0.764
20	36	108	0.727

Javascript Program

This program divided an image into grid points, allowing us to select the grid points we wanted to use.



CMSC Courses Used

CMSC 381 - Image Processing

CMSC 280 - Experience learning a new language, this helped with learning HTML.

CMSC 262 - Data Structures (pair programming), git, Reading others code

CMSC 208 - LaTeX

References

https://en.wikipedia.org/wiki/Non-negative_matrix_factorization

<http://oldbird.org/pubs/fcmb/species/sparrows/wtsp/wtsp.htm>

<http://oldbird.org/pubs/fcmb/species/sparrows/swsp/swsp.htm>

<http://oldbird.org/pubs/fcmb/species/sparrows/savs/savs.htm>

<http://oldbird.org/pubs/fcmb/species/warblers/amre/amrenfc.htm>

Questions?