IntelliChirp

Machine Learning Classification of Acoustic Data Components

Steven Enriquez | Michael Ewers | Joshua Kruse | Zhenyu Lei

Team Lead Recorder Architect Testing Lead

Clients: Colin Quinn | Patrick Burns

Mentor: Fabio Santos

"Recent work incorporating long-term surveys and radar remote sensing suggests a drastic decline of **2.9 billion birds** in North America since 1970 (Rosenberg et al. 2019)"

"A report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found that about **1 million animal and plant species** are now threatened with extinction"

Our Clients

Colin Quinn
PhD Student NAU

Soundscapes2Landscapes

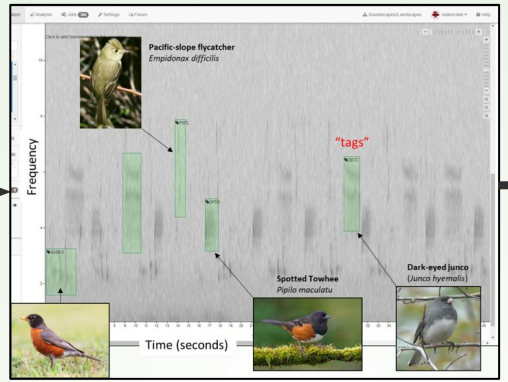
Current Value **$1.1 million**

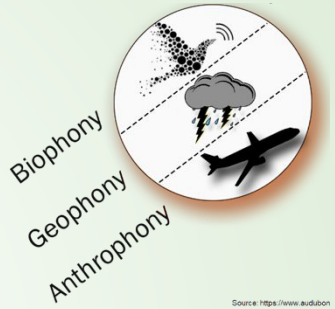
Patrick Burns
Research Associate

The Process

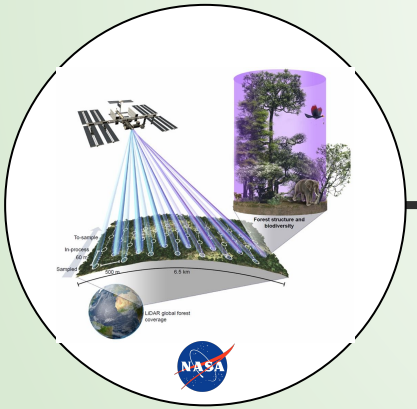
Soundscape Recording Data

Sound Identification/Analysis

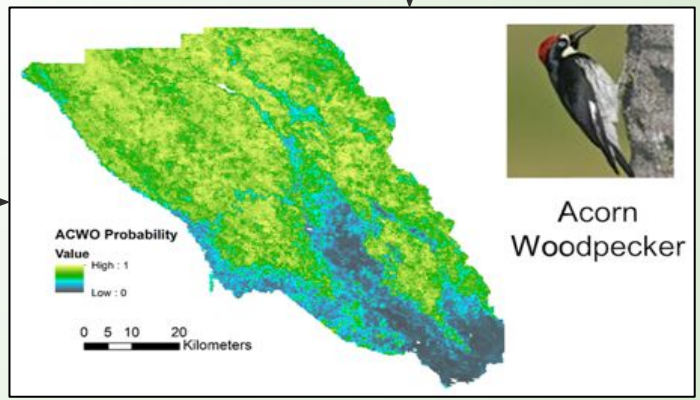




Identify Layers



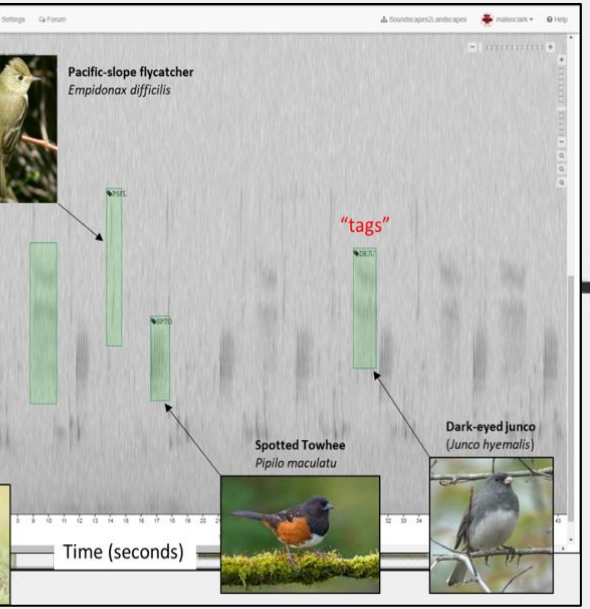
Satellite Imagery

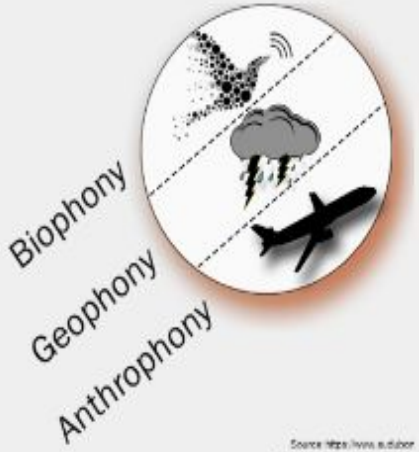


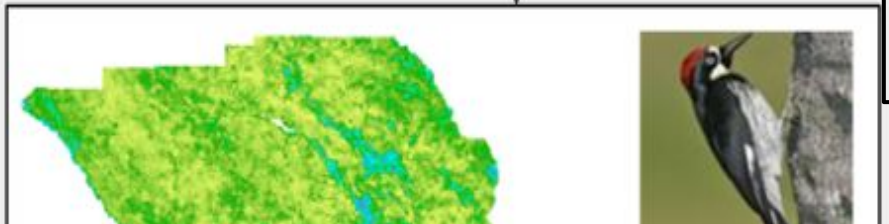
Species Distribution Model

Sound Identification/Analysis

What's Wrong?







Time Consuming

10 TB of Audio Data and Sound identification is done manually

Not Volunteer Friendly

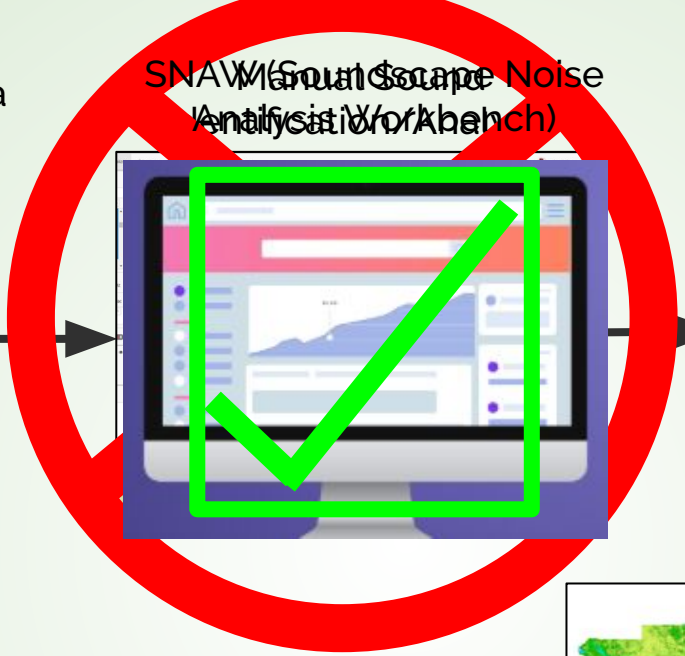
Volunteers are unable to use the current analysis tool

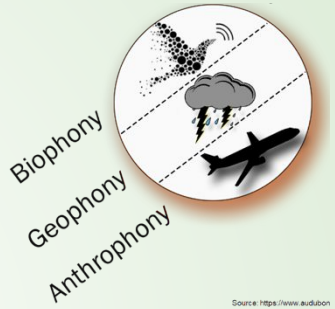
Current Process

Soundscape Recording Data

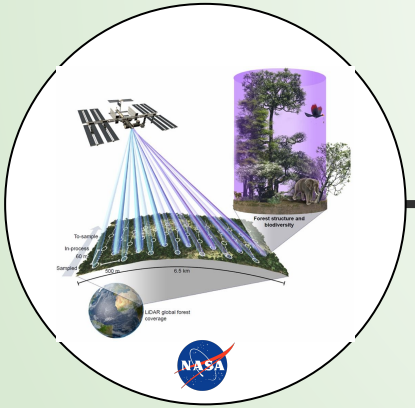
~~SNAW (Soundscape Noise Analysis Workbench)~~

~~Manual Soundscape Identification Analysis~~

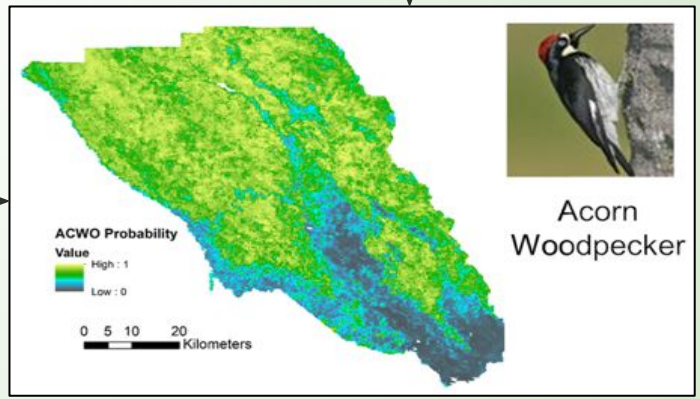




Identify Layers



Satellite Imagery



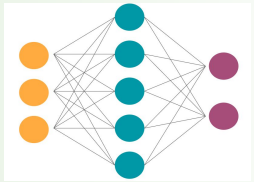
Species Distribution Model

The Solution

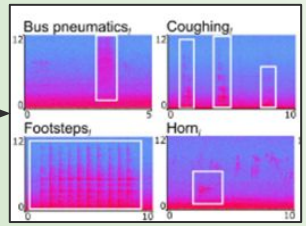
Soundscape Noise Analysis Workbench (SNAW)

Web App

Upload Audio Files



Machine Learning Analysis

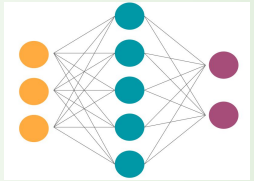


Visualize Results

Export

Standalone Application

Point to Folder of Audio Files

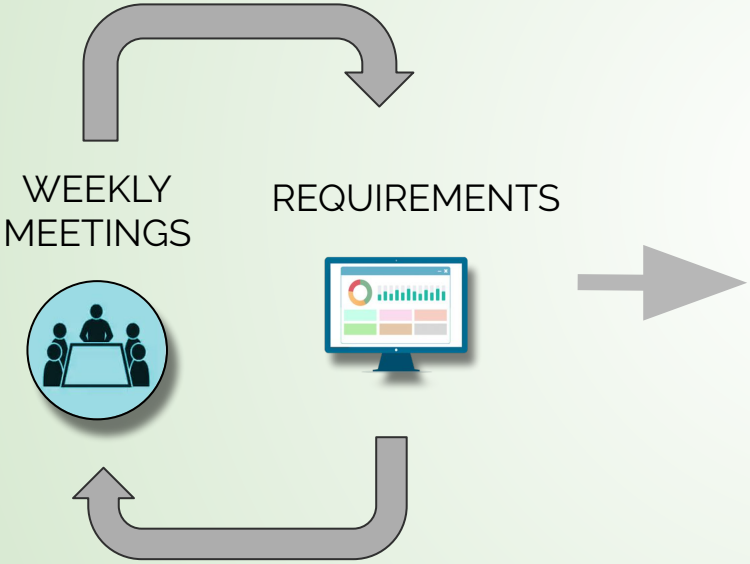


Machine Learning Analysis

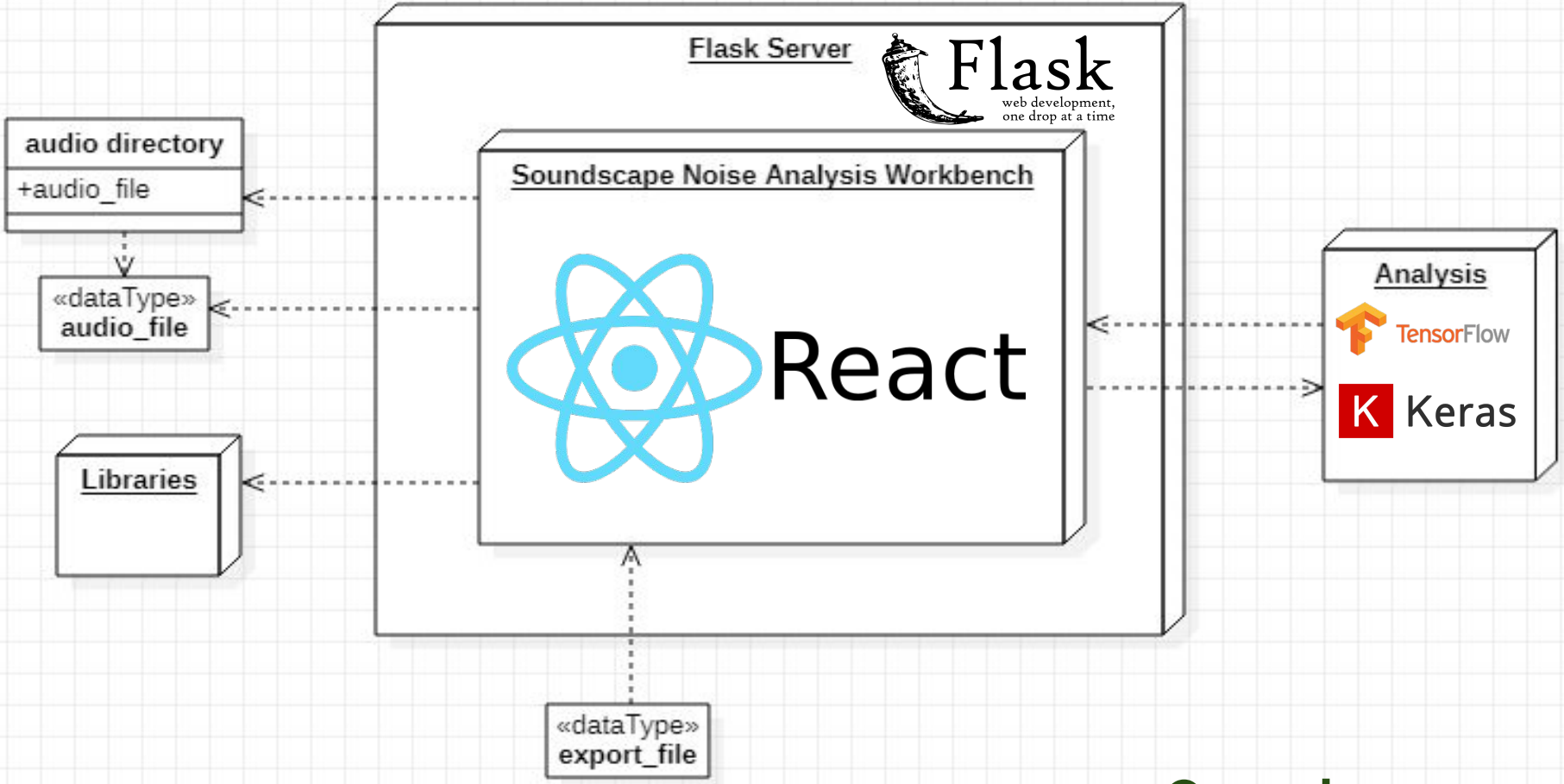
Export

Requirements Overview

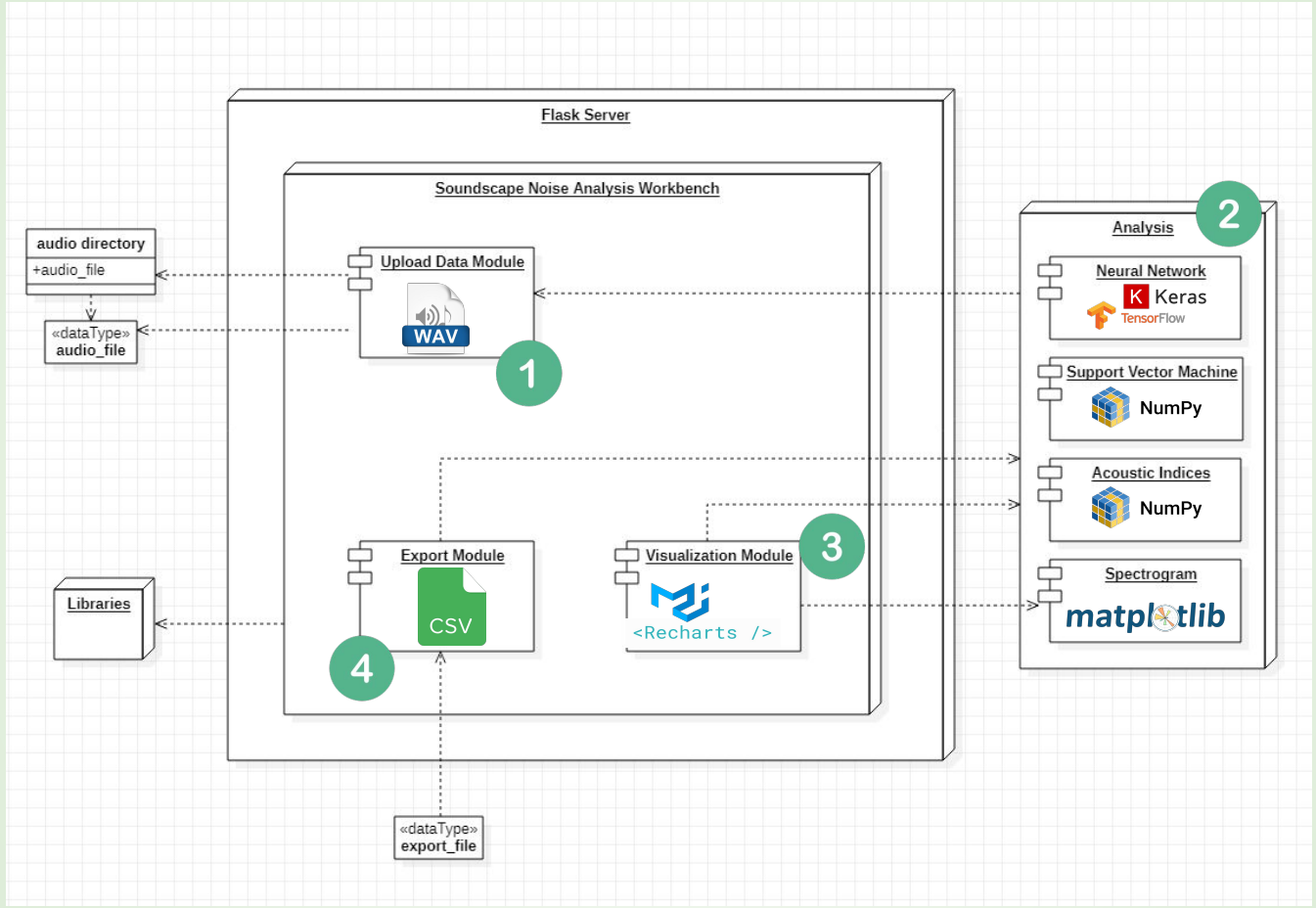
Acquisition → Key Requirements

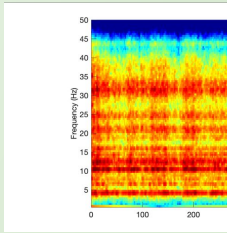


- Application will be able to **upload audio file/s** in **WAV** format.
- M.L. algorithm will **classify individual sounds** in user uploaded audio file/s.
- Application will **display the results** of the completed M.L. analysis.
- Application will be able to **export the results** of the analysis.
- The application will be able to be used **offline** in the field.

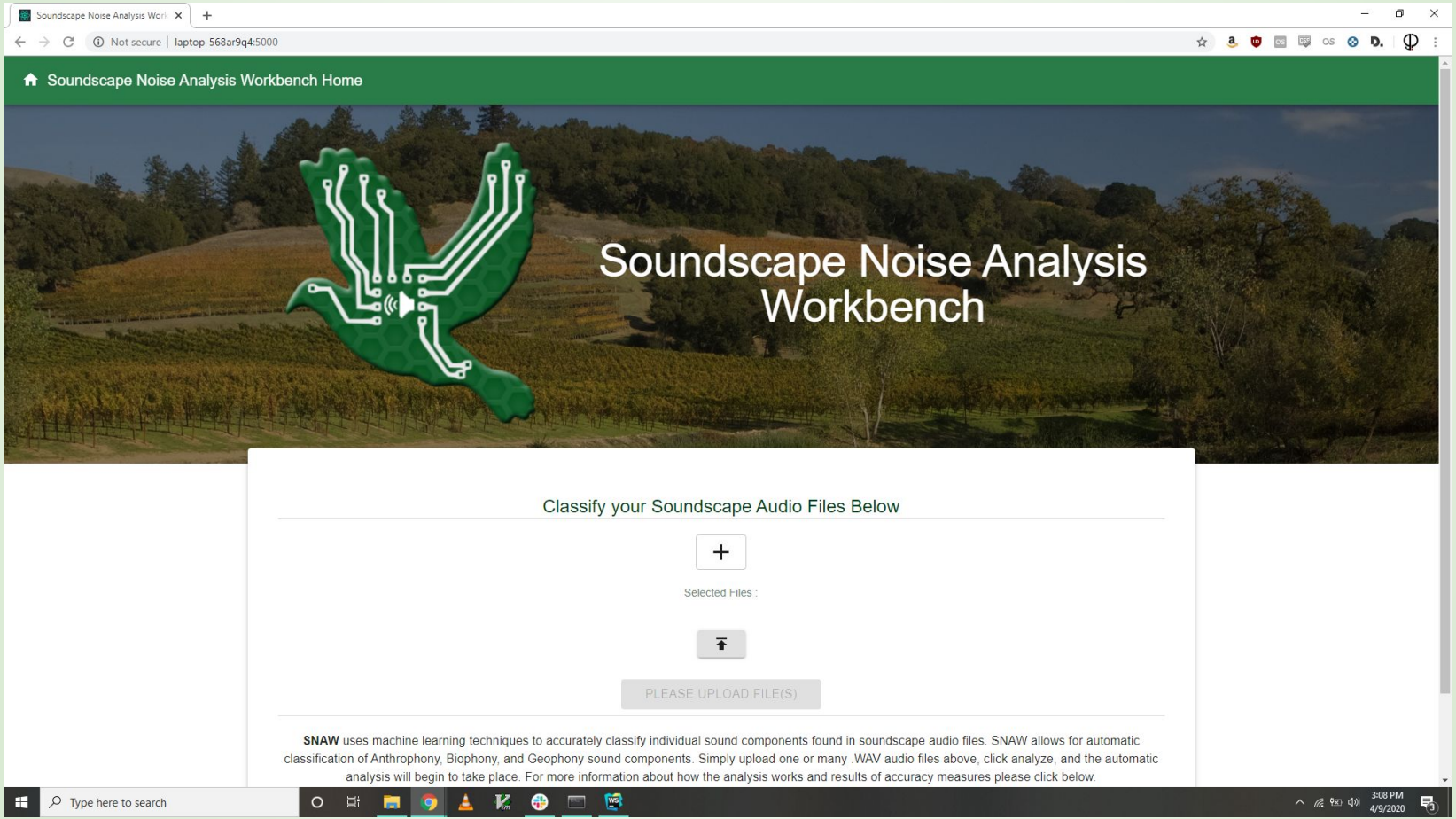

Flask Server
Flask
web development,
one drop at a time
audio directory
+audio_file
«dataType»
audio_file
Soundscape Noise Analysis Workbench
React
Analysis
TensorFlow
K
Keras
Libraries
«dataType»
export_file

Overview

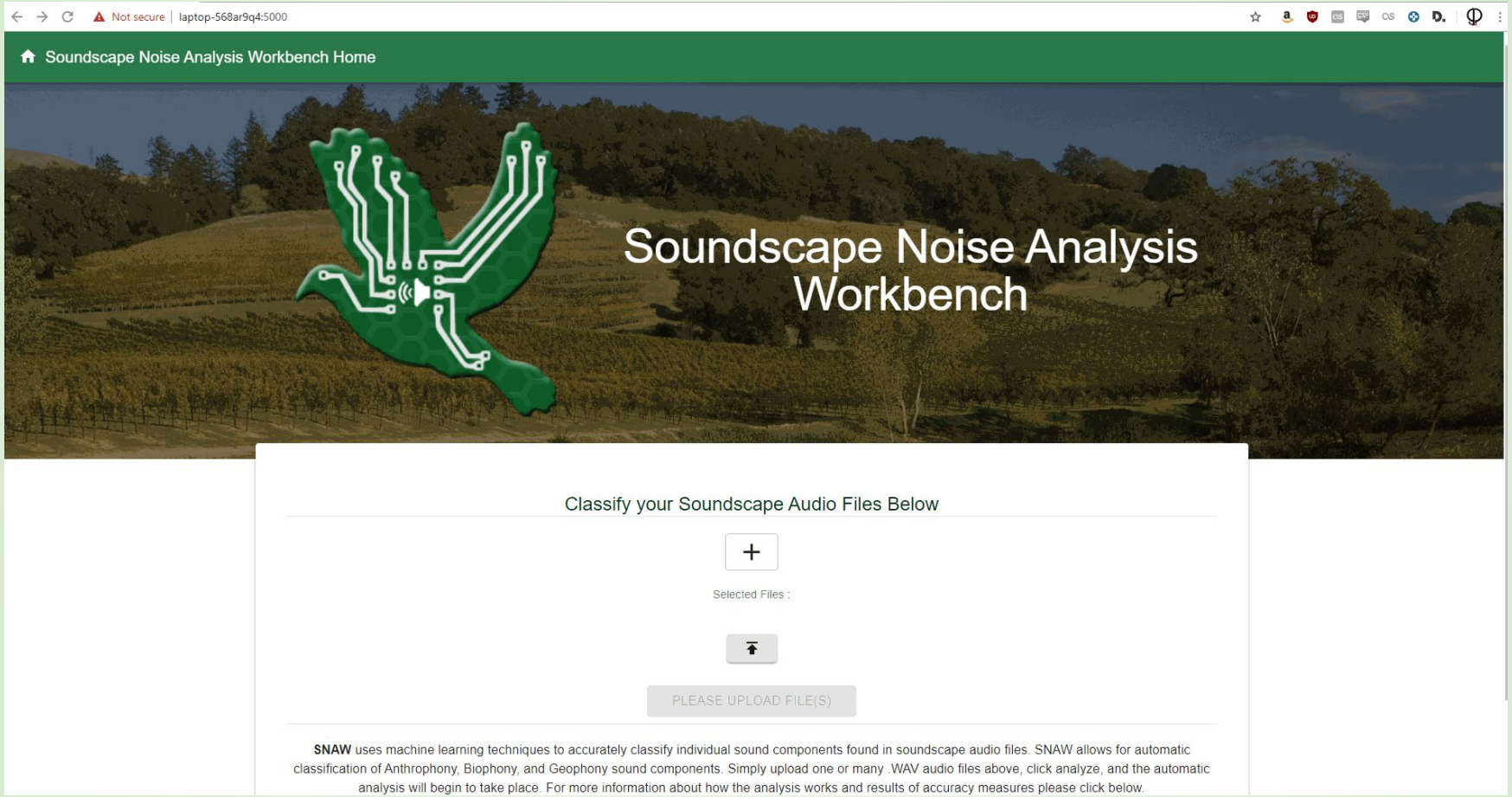

Flask Server
Soundscape Noise Analysis Workbench
audio directory
+audio_file
«dataType»
audio_file
Upload Data Module
WAV
1
Export Module
CSV
4
Visualization Module
<Recharts />
3
Libraries
«dataType»
export_file
Analysis
2
Neural Network
Keras
TensorFlow
Support Vector Machine
NumPy
Acoustic Indices
NumPy
Spectrogram
matplotlib



Demo - Intro


Soundscape Noise Analysis Work
Not secure | laptop-568ar9q4:5000
Soundscape Noise Analysis Workbench Home
Soundscape Noise Analysis Workbench
Classify your Soundscape Audio Files Below
Selected Files :
PLEASE UPLOAD FILE(S)
SNAW uses machine learning techniques to accurately classify individual sound components found in soundscape audio files. SNAW allows for automatic classification of Anthrophony, Biophony, and Geophony sound components. Simply upload one or many .WAV audio files above, click analyze, and the automatic analysis will begin to take place. For more information about how the analysis works and results of accuracy measures please click below.
Type here to search
3:08 PM
4/9/2020

Demo - Upload


Not secure | laptop-568ar9q4:5000
Soundscape Noise Analysis Workbench Home
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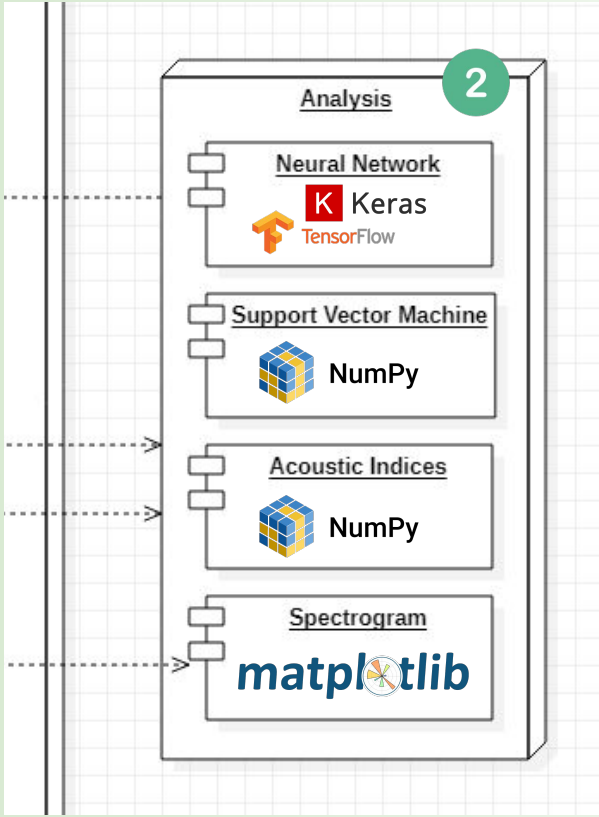
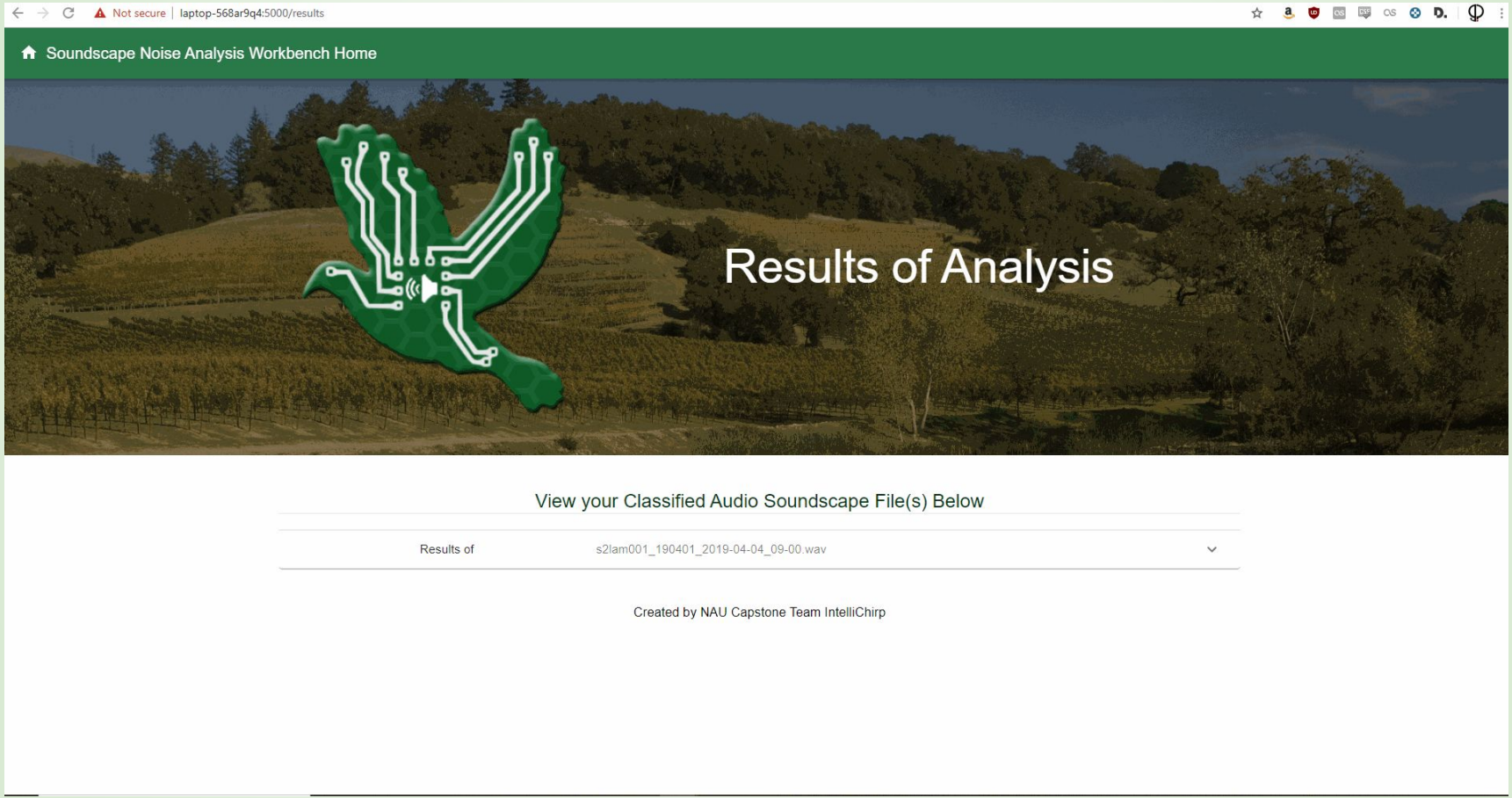
Demo - Analysis

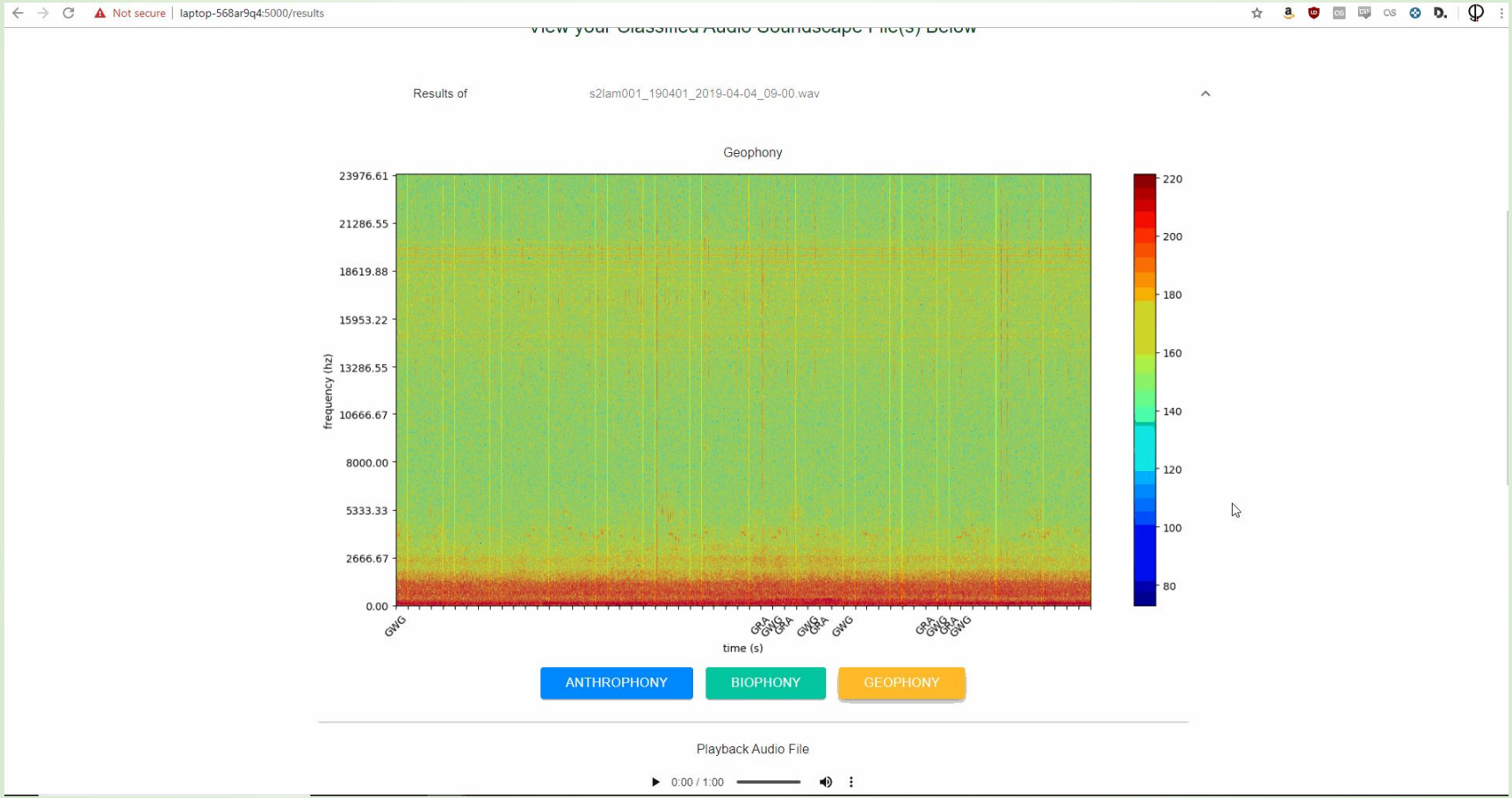


- **Neural Network Module**
  - Convolutional Neural Network trained on Sonoma County Data
  - Calculates a prediction for each sound component present at 1 second intervals
- **Acoustic Indices Module**
  - Calculates audio statistics used by researchers
- **Spectrogram Module**
  - Creates a spectrogram image for the audio file

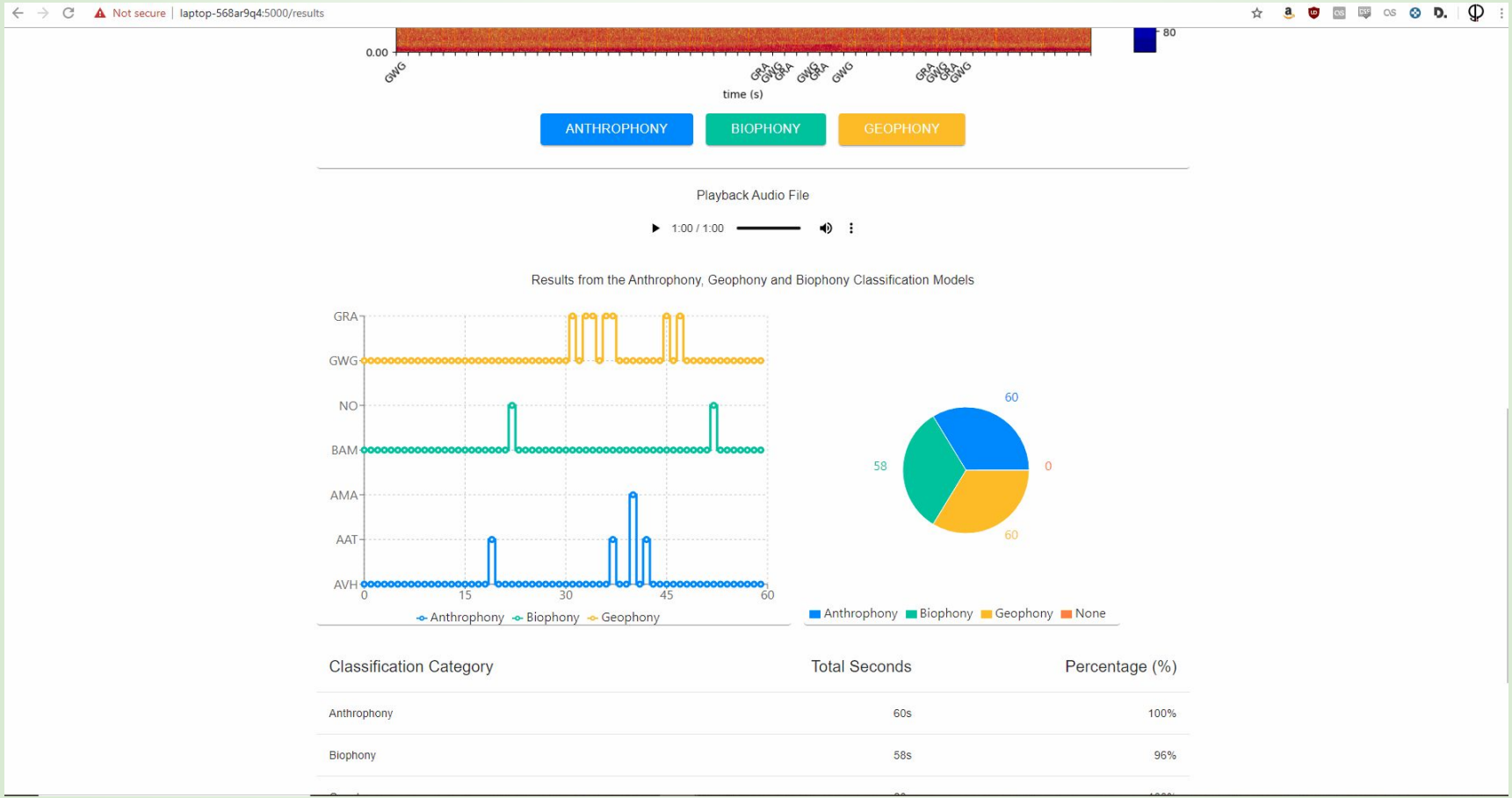
Demo - Visualization



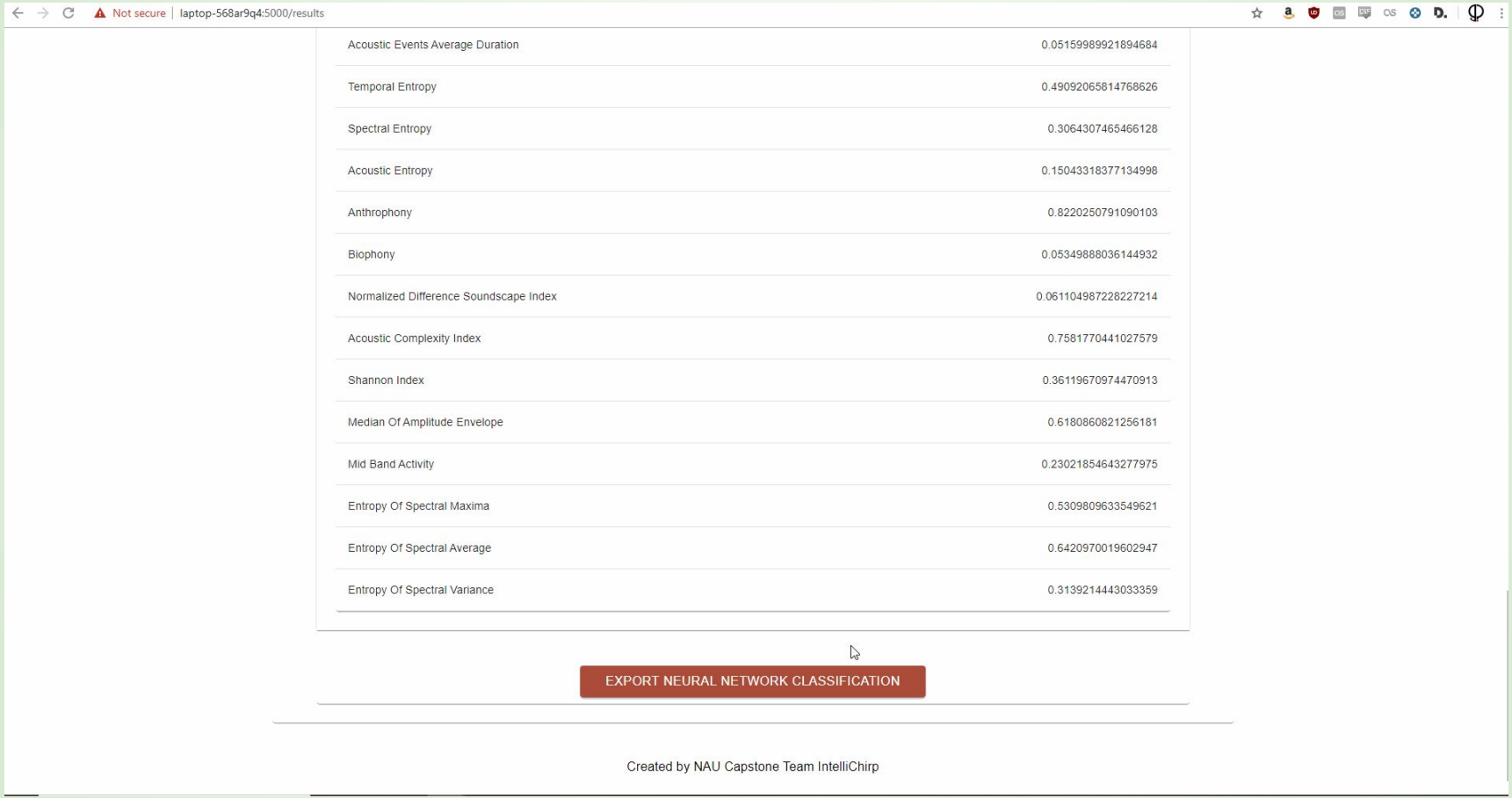
Demo - Visualization



Demo - Visualization



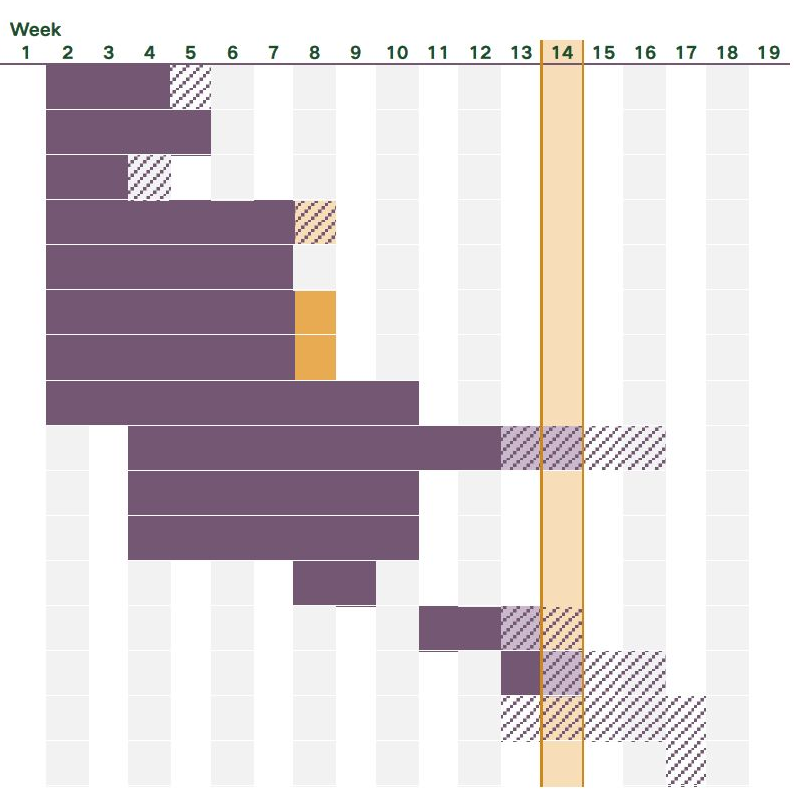
Demo - Export


Not secure | laptop-568ar9q4:5000/results
Acoustic Events Average Duration 0.05159989921894684
Temporal Entropy 0.49092065814768626
Spectral Entropy 0.3064307465466128
Acoustic Entropy 0.15043318377134998
Anthrophony 0.8220250791090103
Biophony 0.05349888036144932
Normalized Difference Soundscape Index 0.06110498722822714
Acoustic Complexity Index 0.7581770441027579
Shannon Index 0.36119670974470913
Median Of Amplitude Envelope 0.6180860821256181
Mid Band Activity 0.23021854643277975
Entropy Of Spectral Maxima 0.5309809633549621
Entropy Of Spectral Average 0.6420970019602947
Entropy Of Spectral Variance 0.3139214443033359
EXPORT NEURAL NETWORK CLASSIFICATION
Created by NAU Capstone Team IntelliChirp

Challenges	Resolutions
Improving Neural Network Implementation	**Training the Neural Network** with a solid set of training data from onsite recorders and open source datasets.
Gathering more training data	**Manual** audio **classification sessions** with clients.
Create an offline version that can be run on a **HPC cluster**	Gradually **adapting web application code base** to have the same execution, all in **one command line script.**

Schedule

	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
MileStone I: MVP	2	4	2	3	100%
Software Design Document	2	4	2	4	100%
Upload Data Module	2	3	2	2	100%
Analysis Module	2	6	2	7	90%
Standalone Offline Module	2	6	2	6	100%
Export Module	2	6	2	7	100%
Visualization Module	2	6	2	7	100%
Phase 1: Application Optimization	2	9	2	9	100%
Phase 2: Improving Neural Network	4	13	4	11	90%
Phase 3: Front-End Improvements	4	7	4	7	100%
Phase 4: Implementation	4	7	4	7	100%
MileStone II: Full Prototype Tech Demo	8	2	8	2	100%
Phase 5: Testing and Bug Fixing	11	4	11	3	80%
MileStone III: Almost Deliverable Product	13	4	13	2	80%
Phase 6: Official Release	13	5	N/A	N/A	0%
Final Project Delivery	17	1	N/A	N/A	0%



Testing Plan

Unit Testing

Integration Testing

Usability Testing

Upload Module

Analysis Module

Visualization Module

Export Module

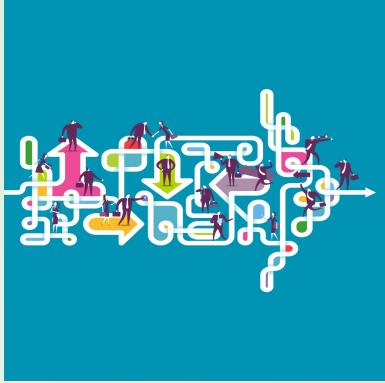
Upload Module connected to the Analysis Module

Analysis Module connected to the Visualization Module

Visualization Module connected to the Export Module

Observe users interaction with our application

Future Work



- Further improve the machine learning algorithms

- Can analyze sound more detailedly, such as identifying bird species

In Conclusion

Problem

An application that determines biodiversity through manual identification

Solution

The Soundscape Noise Analysis Workbench which uses machine learning to automatically identify the biodiversity

IntelliChirp

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