Interactive Webtool for Tempospatial Data and Visual Audio Analysis

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Abstract

To solve VAST Mini Challenge 1, we build an interactive visualization tool that allows hypothesis testing and exploratory analysis of the data. The tool contains different visualizations for metadata and audio data analysis. To analyze the recorded bird calls, we trained a Gradient Boosting-classifier to distinguish different bird species. Our tool integrates these results and visualizes them in combination with additional data allowing the user to get context information and confirm the results.

Index Terms: Visual Analytics—Visualization—Visualization techniques

1 Introduction

This paper provides an overview of our submission to the VAST Challenge 2018 Mini Challenge 1 (MC1). The scenario is based on the last year’s challenge, where the findings were that a company called Kasios was dumping chemicals in a wildlife preserve. The chemical is suspected to effect the species of the Rose-Crested Blue Pipit, especially the mating behavior. This year, Kasios states that the dumping has no effect on the bird population and that the Rose-Crested Blue Pipit would be living in great condition all over the preserve. The task of MC1 is to analyze patterns of spatial movement of all bird species as well as records of bird calls and songs and to create hypotheses concerning the state of the Rose-Crested Blue Pipit. As basis for the analysis we analyze 2081 records of bird songs recorded all over the preserve over the course of 35 years together with metadata, containing the location, species, time stamp and the quality of the record. In addition, Kasios provides 15 audio records to prove that their dumping has no effect on the bird species.

2 Metadata Visualization

We provide two visualization approaches for the metadata. Map visualizations for the analysis of geo data and a timeseries for finding temporal patterns and anomalies in the calling behavior.

2.1 Map visualizations

Based on the map of the wildlife preserve and the location data for the audio recording, we build different visualizations. For each representation the species is mapped onto the color.

Location Representation

Each data point is plotted onto the map. The size of the points are dynamically adjusted to the time, so smaller circles are further back in time. In addition, the season can be mapped to the outline of the data points. Using this representation we are able to determine migrating birds and birds living in the region of the dumping side. This view can be seen in Image 1.A.

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3 Audio Analysis

To preprocess the audio recordings, we use noise reduction, high-pass and low-pass filtering, and segmentation of individual bird sounds to create high-quality files for classification (Figure 3). Furthermore, we bin the segments by length. Based on those files, well-known spectral features and statistics based on fourier-coefficients are generated. We use a sliding window with the length of 1 second. The extracted features are processed by the lightgbm-classifier \(^1\) which achieved over 90 percent accuracy at 10-fold cross validation on the training set. For the records provided by Kasios, the results are not sufficient for a correct classification. Reasons for the performance on the Kasios data may include the difference between training and test records, insufficient preprocessing and overfitting to noise in the training data. Therefore, we manually investigated the files further using our spectrogram visualizations.

Figure 4.A shows spectrograms of the Kasios recordings where the classified segments are overlaid. This allows the investigation of the predominant bird species in a recording. Additionally, an audio player is integrated for an audible analysis.

Using the t-SNE dimensionality reduction technique as seen in Figure 4.B enables the user to verify the extracted feature metrics using the pre-labeled data. The wide distribution of the Kasios files in the projected space allows the assumption that the files contain many different bird species recordings.

4 Findings

With the help of our web tool we can conclude several findings. Different distribution patterns of bird habitats are recognized and migratory birds detected. Most conspicuous are changed habitats after the dumping. Bird species, for example, the Rose-Crested Blue Pipit or the Green-Tipped Scarlet Pipit are no longer located at the dumping site. Additionally, we observe species influencing each other in their habitat. The timeseries graph reveals that the number of songs for the Rose-Crested Blue Pipit is decreasing which supports the hypothesis that the pairing behavior is disturbed by the dumping and subsequent migration of this species. The visual investigation of the audio files shows that three files are manipulated by Kasios. Only four of the files are classified as the Rose-Crested Blue Pipit.

5 Conclusion and Future Work

Our analysis tool provides an useful overview of the metadata. With clustering, filtering, and different visualizations insights in the data can be generated and hypotheses can be tested. Visualizing the spectrograms in combination with the results of the classifier allows us to verify the performance of the classifier in a detailed manner. The t-SNE projection provides insights into the quality of the extracted features and amplifies the verification of the classifier. With the support of our visualizations, we intend to add and refine our preprocessing steps and enhance the feature extraction techniques to improve our automatic classifier.

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1\(\text{https://github.com/Microsoft/LightGBM}\)