Wilder sensing student projects

Note: In all of the projects please use data/recordings that relate to birds present in the UK.

Multiple Class AI Model Test platform

Abstract

The Wilder Sensing Biodiversity analytics platform uses deep learning in order to detect and classify bird voices from ambient several hundred hours of sound recording each day and extract actionable insights from their behavioural patterns. In order to obtain meaningful insights, the deep learning models must achieve very high accuracy and confidence.

The focus of this project is to enable fast interaction and development of the deep learning models used to detect and classify the bird voices from the ambient sound recording. Models are generated regularly as new data becomes available, hyperparameter optimization, improvements and modifications to the network architecture or a brand new algorithm.

The ability of fast and accurate evaluation of the ML models performance will enable the Wilder sensing project to improve dramatically its ability to obtain clear and accurate data that can be used to establish the bird population biodiversity and its trends.

Outcomes

Expected outcomes:

1. A review of ML models evaluation techniques (lit review)
2. A thorough evaluation of the BirdNET ML platform
3. A number of scripts and tools to run quick evaluation of a new ML model
4. A small database of labelled test sounds that can be used during the tests

Challenges

1. Multiple bird species having very similar voices
2. Variability of sound quality
3. Large Inaccuracy of dataset

Links

1. towardsdatascience.com evaluate-machine-learning-models
2. www.kaggle.com: metrics-multi-class-classification
3. medium.com: evaluating-multi-class-classifiers
4. https://xeno-canto.org

Build a bird voice classification ML Model using ResNet

Abstract

The Wilder Sensing Biodiversity analytics platform uses deep learning in order to detect and classify bird voices from ambient several hundred hours of sound recording each day and extract actionable insights from their behavioural patterns. In order to obtain meaningful insights, the deep learning models must achieve very high accuracy and confidence.

The focus of this project is to train a highly accurate deep learning bird voice classification network. The network architecture will be based on the well established ResNet topology. *BirdNet* is an example of an existing pre-trained neural network based on ResNet; it will be used as a reference point for the work. ResNet and BirdNet have a very broad range of options and hyperparameters that can be modified to optimise the results. These include modification to a wide range of hyperparameters, initialization and starting conditions, network topology (depth and number of layers), as well as the algorithm itself (activation functions, add dropouts, etc).

In order to provide real value and insight from the biodiversity data, it is of paramount importance that the bird voice detection is of exceptional quality and confidence. The quality and accuracy of the ML models are therefore of extreme importance for the success of the Wilder Sensing ambitious goals.

Outcomes

- A review of ResNet, BirdNet and comparison with other topologies (lit review)
- Performances evaluation as hyperparameters are modified
- Performances evaluation as the network topology is modified (number of layers)
- BirdNET benchmark

Links

1. https://www.sciencedirect.com/science/article/pii/S1574954121000273
2. https://en.wikipedia.org/wiki/Residual_neural_network
3. https://towardsdatascience.com/an-overview-of-resnet-and-its-variants-5281e2f56035
4. https://keras.io/api/applications/resnet/\
5. https://xeno-canto.org

Build a bird voice classification ML Model using Mask RCNN

Abstract

The Wilder Sensing Biodiversity analytics platform uses deep learning in order to detect and classify bird voices from ambient several hundred hours of sound recording each day and extract actionable insights from their behavioural patterns. In order to obtain meaningful insights, the deep learning models must achieve very high accuracy and confidence.

The focus of this project is to train a highly accurate deep learning bird voice classification network. The network architecture will be based on the well established Mask RCNN topology. The Mask RCNN architecture has a very broad range of options and hyperparameters that can be modified to optimise the results. These include modification to a wide range of hyperparameters, initialization and starting conditions, network topology (depth and number of layers), as well as the algorithm itself (activation functions, add dropouts, etc). In addition, the Mask RCNN has the ability of creating RoIs around the different bird voices when multiple birds are singing at the same time.

In order to provide real value and insight from the biodiversity data, it is of paramount importance that the bird voice detection is of exceptional quality and confidence. The quality and accuracy of the ML models are therefore of extreme importance for the success of the Wilder Sensing ambitious goals.

Outcomes

- A review of Mask RCNN and comparison with other topologies (lit review)
- Performances evaluation as hyperparameters are modified
- Performances evaluation as the network topology is modified (number of layers)
- BirdNET benchmark

Links

1. https://github.com/matterport/Mask_RCNN
2. https://viso.ai/deep-learning/mask-r-cnn/
3. http://ceur-ws.org/Vol-2936/paper-123.pdf
4. https://xeno-canto.org

Detect bird song in audio clips

Abstract

The Wilder Sensing Biodiversity analytics platform uses deep learning in order to detect and classify bird voices from ambient several hundred hours of sound recording each day and extract actionable insights from their behavioural patterns. In order to obtain meaningful insights, the deep learning models must achieve very high accuracy and confidence.

Deep Networks can be used to detect and classify bird voices, however they are complex algorithms. Often, in order to run a deep learning algorithm within a reasonable time, a very large and powerful machine is required. In order to achieve a scalable ML platform that can cope with the classification of several hundreds of hours of sound recordings, the waveforms must be cleaned of all the portions that are irrelevant or uninteresting. This includes silence, background noise, ambient (wind, water streams, rain) etc; the portion of interest can easily be reduced to less than 5% of the total recording even with a simple threshold based algorithm.

The focus of this project is to derive a number of simple algorithms that can be run by inexpensive edge devices and can be used to drastically reduce the amount of data that needs to be stored and processed. The target architecture is a typical low power, one board computer such as a raspberry pi or a beagleboard.

One of the solutions widely used to preprocess audio data for machine learning models is through *Librosa*. In this project, the *librosa* functionality for sound processing and analysis will be reviewed with the intent of developing a simple algorithm for bird sound detection that can run on a low power edge device.

Outcomes

1. Review of simple noise processing techniques like *Librosa*
2. Simple threshold with smoothing and debouncing filter
3. Frequency domain simple filter
4. A number of scripts and tools to run the filtering algorithm
5. A thorough evaluation of the accuracy of the algorithms

Challenges

Links

1. https://librosa.org/doc/latest/index.html
2. https://my.eng.utah.edu/~cs5780/debouncing.pdf

Analytics of biodiversity data for land managers

Abstract

The Wilder Sensing Biodiversity analytics platform uses deep learning in order to detect and classify bird voices from ambient several hundred hours of sound recording each day and extract actionable insights from their behavioural patterns. In order to obtain meaningful insights, the deep learning models must achieve very high accuracy and confidence.

Land managers in the UK can use biodiversity data in a variety of ways for a very diverse range of purposes. These include understanding the migration pattern of long and short distance migratory birds during the mating season, the overall population level and its fluctuation; establish the correlation between environmental factors affecting bird decline as a result of human activity, deforestation and repurposing of land to agricultural or residential, climate change and others. The project will involve a number of sessions with a selection of land managers for large natural estates within the UK in order to determine the requirements they have in relation to biodiversity data and build a number of analytics dashboards to address those needs. The dashboard will be authored using established BI tools and take advantage of big data technology.

Data driven decision making has become one of the biggest buzzwords in recent years across both the public and private sectors. The benefits and insights contained within a big data warehouse are however lost without the ability to render the data in a simple and visually appealing analytics dashboard. The success of the

Outcomes

1. Review of data visualisation and analytics dashboard authoring (lit review)
2. An online database of bird voice recording training/test set
3. Prototype a BigData analytics platform on AWS using ETL/pySpark
4. Create ETL jobs for simple aggregates of bird species
5. Identify and document the use cases of biodiversity data for natural estate managers
6. How can this data support key government initiatives such Biodiversity Net Gain
7. Create a number of analytics dashboards to address such questions
8. Produce a case study with one land manager with a tailored dashboard
9. Produce a report on land managers feedback and ideas for the future

Links

1. https://www.datapine.com/blog/dashboard-design-principles-and-best-practices/
2. https://dataschool.com/how-to-design-a-dashboard/
3. https://aws.amazon.com/blogs/big-data/build-a-data-lake-foundation-with-aws-glue-and-amazon-s3/
4. https://cieem.net/ne-biodiversity-credits-scheme/

Data mining for the bird sound Database

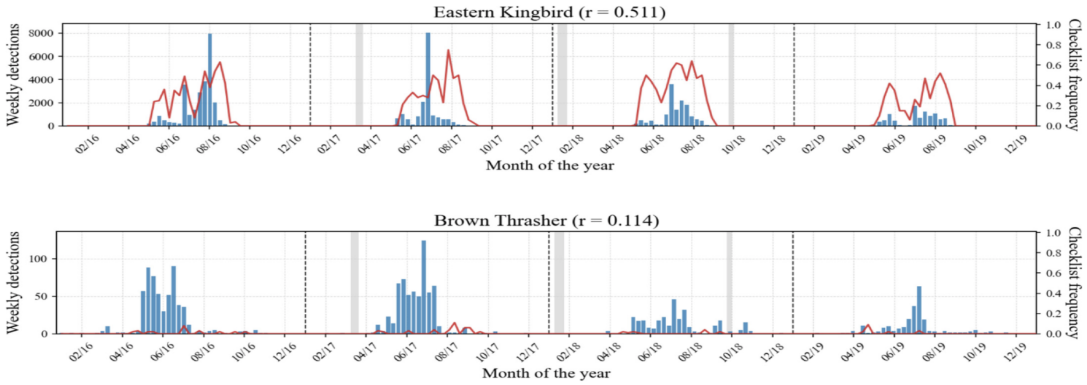
Abstract

Wilder Sensing takes advantage of a variety of data sources in order to collect a thorough picture of bird behaviour and trends across the country. Our Analysis of data will help us in knowing which bird species live in an area, for how long and general trends in their behaviour. The overall goal is to understand the root reasons of such behaviours and deviations from the expected patterns such as a result of deforestation, human activity, climate changes and other macro factors affecting the environment.

This project is focused on data mining analysis of large datasets of UK bird voice recordings. The data comprises the voice recording alongside metadata (recording location, duration, bird species, etc); the data will require cleanup and standardisation in order to take advantage of multiple data sources storing the information in different formats. It will involve the creation of an online data-lake, manual analysis of the data collected and prototype data processing pipeline to derive aggregate values.
The primary source is Xeno-canto where data can be extracted via an api.

Example of statistics

1. Statistics on bird species variations over time across multiple sites
2. Variability of length across bird species
3. Variability of Pitch across bird species
4. Patterns that can be used to discriminate bird sounds from ambient noise



Outcomes

- Review of data visualisation and analytics dashboard authoring (lit review)
- Prototype a BigData analytics platform on AWS using ETL/pySpark
- Create ETL jobs for simple aggregates of bird species

Tools

- https://xeno-canto.org
- https://www.bto.org
- Amazon data-lake technologies (S3/Athena/Glue/Quicksight)

- Python scientific stack (numpy, pandas, scipy, Matplotlib, Seaborn)

Data augmentation of Bird audio data for deep learning training

Abstract

The Wilder Sensing Biodiversity analytics platform uses deep learning in order to detect and classify bird voices from ambient several hundred hours of sound recording each day and extract actionable insights from their behavioural patterns. In order to obtain meaningful insights, the deep learning models must achieve very high accuracy and confidence.

Deep learning algorithms, especially residual networks such as ResNet and RCNN networks, require a very large amount of labelled data in order to train the very large number of parameters contained within them. A very common technique to improve the training data set is to use augmentation. This involves a number of transformations applied to the data points without impairing the accuracy of their labels. In the context of this project, a number of transformations can be applied to the bird sound database including temporal stretch, change of pitch, addition of noise, superposition of multiple sounds in particular ambient noise, human voices etc. The project will involve a validation of the technique used whereby the augmented sounds are tested to ensure the transformations have not affected the validity of their labels.

The ability to transform and augment bird as well as other animals and insects voice data will be of immense value for projects such as Wilder Sensing. It will enable the creation of much more accurate and powerful algorithms and, as a result, much more accurate databases of biodiversity and its deterioration.

Outcomes

1. A database of known (labelled) bird sounds, focus on 100 species
2. A database of ambient noise (50h recording)
3. Scripts and tools to generate augmented data
4. A review of the benefits of data augmentation

Links

1. https://en.wikipedia.org/wiki/Data_augmentation
2. https://www.ofai.at/~jan.schlueter/pubs/2015_ismir.pdf
3. https://zenodo.org/record/1066137#.Yr7B-NLMKV4
4. https://aporee.org/maps/