Nocturnal bird migration on the Baltic Sea coast

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Introduction

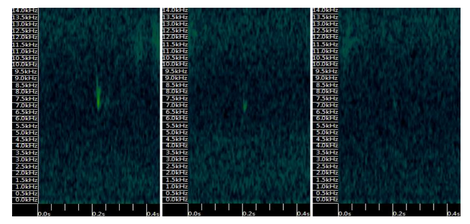
Bird-ringing programmes and direct observations are the most popular bird research methods. However, these techniques have some limitations – they are time consuming, need expert knowledge and the information is collected mostly during the day, whereas most bird species migrate at night. To support the traditional methods, modern technologies such as tracking geolocators, radar monitoring, thermal imaging and acoustic recordings are considered.

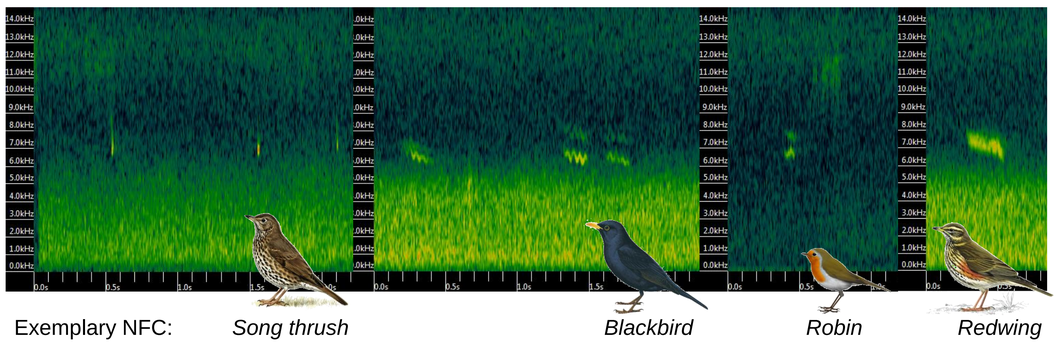
We are trying to extend standard bird monitoring schemes to research on night migration. Months of autumn migration was recorded and part of the data was manually annotated, then parametrised and classified by different methods. Bird acoustic analysis could be useful in monitoring of bird migration and crucial areas protection, for construction planning, collecting the data on migration routes, ranges, biology and habits etc.

Night flight calls

NFC – Night Flight Calls

- ✓ Contact calls used on migration
- ✓ Very short (10-300 ms)
- ✓ Quiet, usually low SNR
- ✓ Only some species use NFC

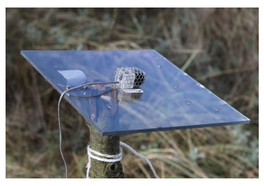




Exemplary NFC: *Song thrush* *Blackbird* *Robin* *Redwing*

Materials and Methods

I Data acquisition



Recordings during autumn bird migration on the Baltic Sea coast in Dąbkowice, West Pomeranian Voivodeship, Poland, at narrow spit between the lake and the sea.

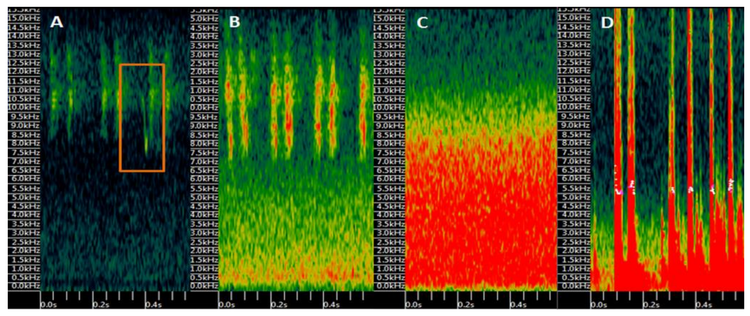
Bird ringing camp nearby.

- ✓ September-October 2016-2018
- ✓ Recordings from sunset till sunrise
- ✓ 5-6 directional microphones, weatherproof system (SM2+ and SMX-NFC mic, Wildlife Acoustics)
- ✓ > 3500 h of recordings per season

II Data structure

- ✓ Manual annotation of passerines calls for some recordings
- ✓ Recordings from different days and various weather conditions
- ✓ Calls are sporadic, only ~1% of positive frames (for 1 s split)

A) grasshoppers frequencies coincide with song thrush call (frame), making the extraction difficult
B) grasshoppers calling in broader band, exactly in the frequencies of song thrush calls, making the sound extraction impossible;
C) strong wind and sound of the sea
D) rain



Parametrisation and Classification

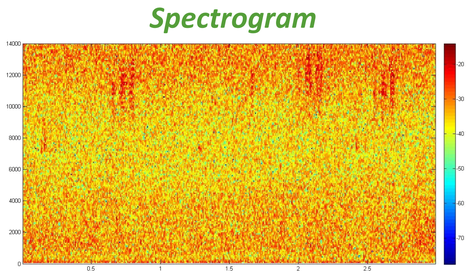
Training set: *25* 30-min annotated recordings. Split to 15 ms frames, features calculated for a subset: all frames labelled as positive(1 – bird present) + the same number of negative frames (0 – no bird)

Testing set: *12* 30-min recordings, as above

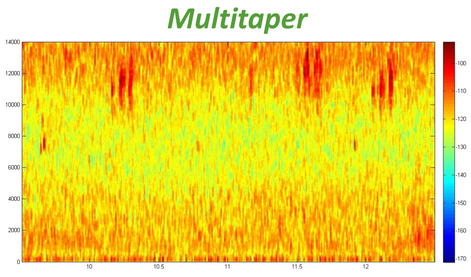
Features: ✓ multitaper spectrum in 5-8.5kHz range
✓ spectral and temporal parameters (e.g. moments, MFCC, pitch etc.)

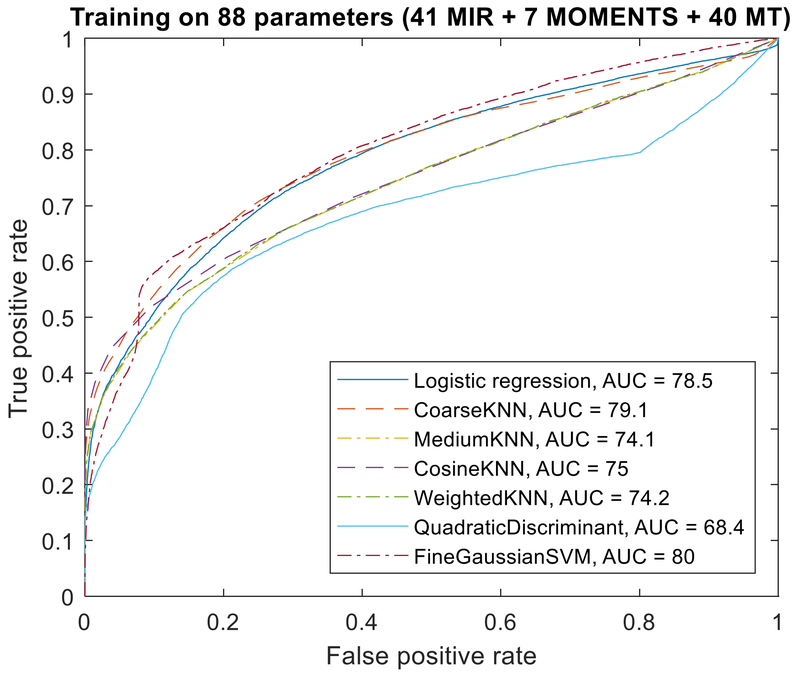
Classification: Logistic Regression, KNN, SVM

Spectrogram



Multitaper





Convolutional Neural Networks

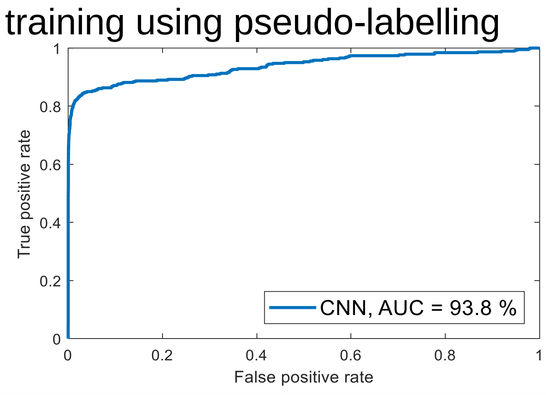
Winning solution from *Bird Audio Detection Challenge 2017* by T. Grill

Training set: *16* 30-min annotated recordings, split to 1 second excerpts

Testing set: *6* 30-min recordings, as above

Features: mel-scaled log-magnitude spectrograms

Classification: 4 convolution + 4 pooling + 3 dense layers
dataset augmented by pitch shifting, second stage training using pseudo-labelling



Conclusions & Plans for the future

The results indicate that standard classifiers are too simple and therefore more advanced techniques such as machine or deep learning should be applied – e.g. CNNs. The acoustics methods combined with advanced classification techniques are showing great potential to supplement the research on nocturnal bird migration.

Plans:

- ✓ Checking other features and signal representations (e.g. multitaper spectrum) as input for CNN
- ✓ Testing and adapting the solutions from DCASE BAD Challenge 2018
- ✓ Recordings of the next seasons, bird species classification, birds occurrence correlation with weather station data

References:

[1] Stowell D. et al, Proc MLSP 2016
[2] Grill T., Schluter J. EUSIPCO Proc 2017
[3] Pamuła H. et al, OSA Proc 2017
[4] Stowell D. et al, Methods Ecol Evol 2018, preprint

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