Object-Oriented Rule-Based Classifier for Blue and Fin whales

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Objective:

To develop a detector and classifier for blue and fin whales foraging calls from passive acoustic data



• Q&A

Motivation and general approach

 Detection of Foraging Calls: computer vision-based technique
Identification of 40Hz and D calls: machine learning algorithm(s)
Conclusions

Scripps' Triton: Scanning PAM data a two-level approach

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Object-oriented Rule-based Recognition --- Algorithm



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Object-oriented Rule-based Recognition --- B call detection

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Separation of "40 Hz" and D calls by duration (DCLDE 2015 dataset)





Feeding calls



General Approach



Principal steps and parameters

- Spectrograms: 9 s long, 1 Hz bins
- Equalization in both directions
- Normalization
- Frequency band: 20-90 Hz
- Convert to a binary image

Computervision-based detector

Principal steps and parameters (cont.)

- De-noise by image dilation and connectedcomponent labeling
- Fix "broken" detections (fill-in holes, dilate)
- Contour extraction
- Localizing the ridge
- Discharge outliers (frequency "jumps")
- Confirm downsweeping

Computervision-based detector



Illustration of main steps: Bm D call 2013-04-17T02:41:30.0 (DCPP-A)

Original image



Equalized image





After dilation and connectedcomponent labeling



Fix "broken" detections; ridge located



The extracted contour is shown in red



Examples of true positives



Bp ''40 Hz'' call 06-Dec-11 06:06:36



Bm D Call 23-Jun-12 11:39:09



Bm D call 25:Jun-12 04:37:40



Bm D call 10-Nov-12 02:44:20



Bm D Call 11-Nov-12 04:52:30



Bm D call 20-Jul-13 16:08:19



Results

- 89.3% of all annotated calls have been detected
- 92.7% of all annotated D calls have been detected;
- 58.9% of annotated "40Hz" calls have been missed;
- 11.2% of total detections were false positives;
- Additional tuning was not performed to avoid overfitting
- More fin whale calls will be added to tune the detector
- The detector can be tuned for two types of calls separately

Logistic Regression Classifiers for 40 Hz and D calls

- The calls de-noised by the computervision-based detector were used
- Each spectrogram was stored as a 50x50 binary image
- The simple logistic regression classifier was capable to identify D and 40 Hz calls with 99% of in-sample and 96% of out-ofsample accuracy

Sampled images (calls spectrograms)

Original

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De-noised



Figures plotted with <displayData.m> copyright (c) 2013, Jason Rebello

Conclusions

- A computer-vision-based algorithm has been developed for detection of blue and fin whale foraging calls in PAM data;
- The detector capability has been demonstrated using the DCLDE2015 LF annotated dataset;
- 89% of the annotated calls have been detected correctly;
- The detector performance can be improved after extending the training set with additional *Bp* 40Hz calls;
- Logistic regression classifier is capable to identify 40Hz and D calls with 96% accuracy when applied to the data denoised by the computer-vision detector

THANK YOU! QUESTIONS?

An original painting of a blue whale feeding by Carl Buell. Copyrighted to John Gatesy and Carl Buell.