Hervé Glotin *

9 UMR, 4 CNRS institutes (IN2SI, INSB, INEE, INSU) ;
Internat. Coll : New York, Cornell univ, Cibra, ONC Canada,... ;
Industry : Cyberio, Sermicro, Orcalab, Dodotronics,... ;
Parc National Port-Cros, Pelagos, Réserves intégrales Italie, Centre Nouragues...

* (glotin@univ-tln.fr http://glotin.univ-tln.fr) Univ Toulon, UMR LSIS and IUF
1. Introduction

2. Material
   - Challenges in long term recording, new opened platforms: JASON, BOMBYX, ...
   - Crowdsourcing: LifeClef, TARA, ...
   - Observatories: Nouragues, PNPC, ANTARES, ONC Canada, ...

3. Methods for scaled bioacoustics
   - Feature learning: Dictionary approaches
   - Scaled Scattering and bioacoustic invariants
   - Advanced Detections and Tracking by passive acoustics
   - Submarine bioacoustics: Indian Ocean, Pacific, Mediterranean Sea, Atlantic
   - Tropical forests survey: Bird classification challenges 10, 50, 100, 500, 1000, 2000 species

4. Conclusion, Result summary and Perspectives
   - New challenges in signal processing and machine learning / Scaled Infinite HMM?
   - New HPC challenges
   - Crowdsourcing / Crowdsolving
   - Online Natural Reserve long term monitoring (Bagaud PNPC 2 To / month)
     => climate and pollution studies
1. Introduction and Objectives

Long-term (> years) automatic monitoring of acoustic diversity to:

(1) estimate and track extreme acoustic diversity
(2) assess acoustic variations within and between years
(3) correlate acoustics variations with global changes
2. Material

Examples in Guyane - Tropical forest

French Guiana, Nouragues CNRS research station
December 2014, Field work by MNHN
9 recording sites in harsh environment
Nouragues (Guyane) station

4 habitats
understory (1.5m) and canopy (25m) microphones
16 weather dataloggers
recording during 3 minutes every 30 minutes

high forest
low forest
swamp forest
rock savannah

(Cred. J. Sueur)
Sound decomposition

- High Forest
- Low Forest
- Rock Savanna
- Swamp Forest

Acoustic diversity indices (H, ACI, AR, Df, etc) – MNHN
Wavelet analysis – LSIS
Spectrogram imare ROIs (sensu Potamitis)

Cred. J. Sueur
. temporal and spatial acoustic heterogeneity assess with acoustic indices on a 3D audio sampling of the tropical forest

. automatic tracking of the singing activity of a focal species, the bird Lipaugus vociferans
Other stations: SABIOD in Alpes Italo-French coll.

Long term soundscape monitoring of wild habitats with diverse conservation status with the support of CFS – Corpo Forestale dello Stato

SM3 long term deployments

- Sassofratino – the first Italian Integral Nature Reserve, created in 1959, granted by the European Diploma, in the core of the National Park “Foreste Casentinesi”, now proposed as UNESCO Nature Reserve. Pristine mixed woodland untouched since 300 years ago. Within SIC/ZPS IT4080001 – RETE NATURA 2000
  Altitude 750m, mixed woodland, access forbidden. Surrounded by other Nature Reserves.

- Dolomiti Bellunesi – SIC IT3230031 "Val Tovanella - Bosconero" - RETE NATURA 2000
  Altitude 1647m, mixed woodland, monitored in 2009

- SIC/ZPS IT3230077 "Foresta del Cansiglio" - RETE NATURA 2000
  Altitude 946m, mixed woodland, some agricultural and touristic activity in the surroundings
Instruments

Wildlife Acoustics SM3, with 4 Lithium batteries and 512GB memory, programmed to record 10 min on / 20 min off, 2 channels, 48 kHz sampling
+ programmable, reliable
- not very quiet (hissy recordings)
(three units deployed, two more planned)

Olympus LS-100 + DIY binaural mic, 200Wh external battery and 256GB memory, records 2 channels, 48 kHz 16 bit, 24h/day for 15 days
+ low noise, high quality recording
- no timer
Sassofratino - Integral Nature Reserve
La Lama 22/09 to 5/10/2014 - simultaneous recording with SM3 (scheduled) and LS100 (14 days continuous) during deer (*Cervus elaphus*) breading season to support population censusing.
<table>
<thead>
<tr>
<th>Site</th>
<th>Recording mode</th>
<th>N files</th>
<th>Total Size</th>
<th>N Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sassofratino</td>
<td>10min every 30min stereo 48kHz sampling</td>
<td>8196 (1366 h)</td>
<td>930 GB</td>
<td>70 - 100 birds</td>
</tr>
<tr>
<td>La Bucaccia 28-05 to 05-07</td>
<td>Continuous 24/24h 3:06 each file stereo 48kHz sampling</td>
<td>105 (325 h)</td>
<td>224 GB</td>
<td>&gt;5 mammals</td>
</tr>
<tr>
<td>La Vetreria 06-07 to 06-08</td>
<td></td>
<td></td>
<td></td>
<td>&gt;5 amphibians</td>
</tr>
<tr>
<td>La Lama 28-08 to 18-09</td>
<td></td>
<td></td>
<td></td>
<td>(8 bats, monitoring planned in 2015)</td>
</tr>
<tr>
<td>La Lama 14-11 to **</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>La Lama 22-09 to 5-10</td>
<td>10min every 30min stereo 48kHz sampling</td>
<td>3545 (591 h)</td>
<td>399 GB</td>
<td>50 – 90 birds</td>
</tr>
<tr>
<td>Casa del Conte *</td>
<td>15 min every hour stereo 48kHz sampling</td>
<td>320 (80 h)</td>
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<td>03-06 to 09-08</td>
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<td>31-08 to 06-09</td>
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<td></td>
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<tr>
<td>21-04 to 04-05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cansiglio *</td>
<td>10min every 30min stereo 48kHz sampling</td>
<td>2174 (362 h)</td>
<td>245 GB</td>
<td>50 – 90 birds</td>
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<tr>
<td>07-06 to 01-07</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-07 to 15-08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palmaria *</td>
<td>10min every 30min stereo 32kHz sampling</td>
<td>506 (84 h)</td>
<td>38 GB</td>
<td>40 – 60 birds</td>
</tr>
<tr>
<td>01-08 to 15-08</td>
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</tr>
</tbody>
</table>
Compact 24h spectrograms show the high density of singing birds from dawn to dusk in the dense forest, and the passages of airplanes (dots on the x axis) (tics every 30 min)

(Cred. G. Pavan)
Analysis and display at different time scales to identify acoustic structures of singing species
La Lama - winter monitoring (December 2014 - March 2015) to hopefully record wolves

4 months scheduled recording with SM3 powered by a car battery

Brinno TLC200Pro + waterproof housing
Time-Lapse camera for long term video recording (1 frame / 5 minute - 3 months)
of the plane in front of the SM3
To be installed on February 2015
SABIOD recordings

- Crowdsourcing
- CNRS IN2SI & INSB & INEE (SABIOD)
- CNRS (INSU) = **68 years** Fe = 100 Hz from 2005 to 2015

Map showing locations such as Vancouver, BIRD, Madagascar, Réunion, and Nvelle Calédonie.
3. METHODS

SABIOD is Interdisciplinary

1) CrowdSourcing (Mobility, Android...)
2) Auto long term high frequency recording (Velocity)
3) Invariant Scaled representations (HPC, wavelet, scattering)
4) Unsupervised annotation (HPC, Infinity class clustering)
5) Supervised classification (HPC, Large class / Deep learning)
6) Information retrieval
7) Ethology / Ecology
8) Anthropic impact / Climat impact / Biodiversity restoration
Methods

- Regularized convex optimization
- Deep Learning
-Sparse coding
- Multiscale signal analysis
- Scaled propagation modeling
- Biomimicry
- New open hardware
3.1 A new HPC system for Big Data Detection Localisation of Marine Mammals

High Performance Computer Acoustic Data Accelerator (HPC-ADA): A New System for Exploring Marine Mammal Acoustics for Big Data Applications

Peter Dugan¹, John Zollweg¹, Herve Glotin⁴,⁵,⁶, Marian Popescu¹, Denise Risch³, Yann LeCun² and Christopher Clark¹

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(2) The Courant Institute of Mathematical Sciences, New York University, NYC, USA
(3) Northeast Fisheries Science Center, NOAA, Woods Hole Oceanographic Institute, MA, USA
(4) Aix Marseille Université, CNRS, ENSAM, LSIS UMR 7296, 13397 Marseille, France
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(6) Institut universitaire de France, 75005 Paris, France

In ICMLulb 2014 workshop, unsupervised traning for Bioacoustics, Beijing 2014, Glotin et al. Ed, sabiod.org
A first large scale benchmark
Sub marine Sounds
classified
on HPC DeLMA in few weeks

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Method One (HPC-ADA)</th>
<th>Method Three (pre-HPC)</th>
<th>Run Time</th>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample Rate</td>
<td>Total Hours (Size</td>
<td>Number of Cores Run</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bytes)</td>
<td>Time (HH:MM:SS)</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
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<tr>
<td>2 kHz</td>
<td>172,896 (4.38 TB)</td>
<td>128</td>
<td>06:00:30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>528:00:00</td>
</tr>
</tbody>
</table>

Table 6. Results showing an example tradeoff between running DeLMA on a larger cloud server (Method One) or desktop workstation (Method Three). An increase efficiency factor of 88:1 can been seen when the HPC-ADA machine analyzes data in parallel with 128 nodes versus a single node being used on the workstation.
3.2 Natural sounds analyses needs
Scaled Learned Representation

➤ Feature learning for fast indexing & classifying

➤ Discovering new spatio temporal pattern for (un)known sources

➤ Scaling the methods
Megaptera Whale song

15 secondes
Infinite HMM for unsupervised segmentation

Units 1, 2, \ldots, t
Results
3.3 Bioacoustic feature learning by Sparse Coding

- Sparse Coding (SC): unsupervised dictionary generated from the complete data set
- SC may be more adapted to the differentiation of natural acoustic sources
- Development of methods for selecting and classifying relevant dictionary atoms
Sparse Coding computation

Why Sparse Coding?
- More discriminative
- Better generalization for new data
- Reduction of the reconstruction error
- Data compression
  - Each data vector \( x_i \) is expressed as a \( c_i \) linear combination of a dictionary \( D \) of size \( K \) (only one in usual K-means)

Formulation:

\[
\arg \min_{D,C} \sum_{i=0}^{N} \| x_i - Dc_i \|^2 + \lambda \| c_i \|_{\ell^1} \quad s.t. \quad \| d_j \|^2 = 1
\]

- \( \lambda \| c_i \|_{\ell^1} \) introduces sparsity (regularization constraint: some contributions are non-zero)
- Iterative learning of \( D \) and \( C \) until convergence by LASSO and K-SVD algorithms
- Complexity for projection in \( \sim O(K n \ nnz) \), \( n \) the number of vectors to project, \( nnz \) the average non-zero coefficients

Humpback whale song analysis by sparse coding: exploring song components

- Humpback songs are structured
  - Most decomposition algorithms use prior information

- Unsupervised determination of recurrent pattern in a data flow
  - Usually clustering
  - K-means clustering drawbacks:
    - Each cluster may not cover all the space
    - Each cluster not suit the data.

- This study:
  - Validate the “subunit” component hypothesis
  - Propose a method to automatically classify song species by the “subunit” components of the song

* Material: Songs recorded in Madagascar, Reunion & New Caledonia, Tonga, Hawai...  
48 kHz FS, from 2008 to 2014 (no 2010 neither 2011)  
13 MFCCs, 10 ms frame shift, 32 ms frame length  
N windows are concatenated to desired T scale (250 ms
The 16 most 'articulated' words (max. time and quefrency variations) are whale's ARTICULATIONS

duration per patch = 250 ms , abscissa = time, ordinates = 12 MFCC
Word Sequence analysis by bigrams 'xy':
\[ P( xy ) = P\left( \arg\max(c_i(t)) = x, \arg\max(c_i(t+1)) = y \right) \]
Long term WHALE SONG EVOLUTION shown by Sparse Coding

Year evolution from A to B = $\log\left( \frac{P(xy, A)}{P(xy, B)} \right)$

$D = B - A = 1$ year

$D = 4$ years

$D = 5$ years

$D = 6$ years
Perspective on Sparse Coding for dialects

We built by unsupervised dictionary learning a proto-lexicon of the song of the humpback whale

Long term systemic units are efficiently extracted and show the variation of the composition of the songs from one year to another

=> WORLD SCALE BIOPOPULATION ANALYSIS

Doh 2014 Phd Thesis ]
3.4 Scaled Tracking by Sparse Coding

Replace cross. corr
By cosine similarity measure:

\[ \cos(A,B) = \frac{A \cdot B}{\|A\| \cdot \|B\|}, \]

Higher the cosine is, the more the vectors are correlated,
FAST vectorial implementation / parallel processing:

\[ \text{allcosines}(h1, h2) = \frac{(H1 \ast H2')}{\text{norm}(H1') \ast \text{norm}(H2)}, \]

where Hi is the matrix of the 1024 by 10 minutes frames,
* is the matrix product,
norm(Hi) is the L2 norm of each frame vector of Hi.
Scaled Tracking of unknown patterns: a case study on Minke whale

- Minimize the reconstruction error

- Allows good generalization for undetermined data

- No need for any knowledge on the target (the boing): the sparse coding shall reconstruct in priority the frequent and high SNR events (e.g. the boings).

⇒ We aim first to show that sparse coding will infer a simple boing matching process.

⇒ Auto-correlation may give similar matching patterns, but our sparse vector representation will allow very fast cosine similarity computation

Duration ~ 2 seconds
Sample of Minke whale boing (from Rankin and al.)
Scaled Sparse Time Delay of Arrival estimations applied to Voicing of Whales (Minke) on 10 minutes recordings

Direct CrossCorr(s1, s2)

Sparse code correlation:
Cosinus(SC(s1), SC(s2))
with dictionary learned on s1 U s2

Also in [Hervé GLOTIN - Joseph RAZIK - GIRAUDET Pascale - Sébastien PARIS - Frédéric BÉNARD Sparse coding for fast minke whale tracking with Hawaiian bottom mounted hydrophones”, International Workshop on Detection, Classification, Localization & Density Estimation of Marine Mammals using Passive Acoustics, Portland, USA, supported by ONR Dpt of the Navy & Acoustical Society of America (ASA) 2011]
Time Delay Estimation by Sparse Coding

Computation of cosine between each vector pair from $h_i$ and $h_j$

This representation allows a global analysis (far echoes...)

(Below we show in red the 0 delay diagonal)

Similarities in (h1,h3) Hawaiin data of 10 minutes (NN26, frame shift 20 ms)

The periodic global patterns due to the regularly spaced vocalisations (1 each 2 min)

We will only consider maxima near the diagonal.
Clear « kernel » patterns that have the duration of the boinging sounds (= 2 sec).

The maximum of each kernel are measured iteratively to get the times on $h_1$, $h_3$

Then: $\text{TDOA}(h_1,h_3) = T(h_1) - T(h_3) = -1.3 \text{ s}$
Time Delays Of Arrival Estimations

We extract 14 TDOA over these 30 minutes, between h1, h3, h4, h6

=> Coherent and regular variations
Conclusion on scaled tracking

- Efficiently match minke boing sounds through cosine of sparse projections
  Without any target knowledge

- Clear boing detection on hydrophone pairs
  TDOA generated straightforward coherent track with correct speed

- Other set of TDOA detected
  A second minke whale?
  We work further on that question.

- Perspectives
  Process our algorithm in the whole microphone array
  Consider virtual hydrophones.
  Date other local max cosine similarities to extract the other present whales
3.5 Astrophysics meets bioacoustics
reliable 3D tracking on tiny array

Array = Only 2 meters long
Once deployed on the sea floor, the frame was connected to the optical cable by a ROV (Remotely Operated Vehicle).

We thank INFN, NEMO, Ricobenne and G. Pavan for the record samples.
LSIS results: 15 August 2005 15h00, Sicile Est:
2PC dive together from -400 m to -1000 m in 5 minutes

[Benard Glotin, in Applied Acoustics 2011]
Demonstration on real data:

[ Patent Glotin et al. Multiple whale tracking USA patent 2013
Bénard Glotin, Neutrino whale tracking, Applied Acoustics 2011 ]

Online demo at http://sabiod.org/tv
RANGE [ 500 to 5000 m] prec :15m
3.6 Large scale whale monitoring

Côte Azur

Sperm whale size estimation by acoustics - DECAV PELAGOS PROJECT
ONline CETacean Tracking, CNRS SABIO - http://glotin.univ-tln.fr/oncet

[ 2013 Abeille Phd, Glotin - Coll G. Pavan
2014 Doh Phd, Glotin - Coll Adam ]
Long term monitoring on ANTARES neutrino OBSERVATORY
12 lines
25 storeys / line
3 PMT / storey

40 km to shore

Junction box

Readout cables

P. Vernin from F. Montanet
Variation of the detection in the day

FULL DAY (by bin of 2 hours)

4 months resumed in one day cycle

[ DECAN PELAGOS PROJECT 2013 Glotin et al. ]
MOON EFFECT

[DECAN PELAGOS PROJECT 2013 Glotin et al.]
Long term series demonstrate Interval Inter Clicks (ICI) variations:
ICI(new-moon) >> ICI(full moon)

Interpretation: full moon light could result in a higher prey concentration at small depth water layers.

Thus, sperm whales are more often predating in this higher prey density at full moon, than at new moon.
BOAT NOISE ( < 500 Hz) daily variation

[ DECAN PELAGOS PROJECT 2013 Glotin et al. ]
NOISE EFFECT
Variation detection de Stenella (haut) et Physeter (bas) (avec int. conf. 95%)

% detec.

Stenella

Physeter

Low noise
High noise

energie(BF) < mediane, energie(BF) > mediane

[ DECAN PELAGOS PROJECT 2013 Glotin et al. ]
Discussion

- Online detection of 2 species
- Effect of the moon
- Different effects of the anthropic noises
- Refined distance estimation will allow better biopopulation studies
3.7 Other long term acoustic series

(temperate ecosystem, Parc Naturel Marin d’Iroise, May-Nov 2011)

The sonic activities of marine fauna holds on at night time with extrema at sunrise and sunset. These activities are modulated by lunar rhythm and seasonal variation (maximum of biomass) between August and October.

Weak sound production at day time.

High sound production at night time.

Seasonal variation synchronized with the maximum of biomass.

Modulation with the lunar cycle.

[Credit C. Gervaise et al. 2013-2015, to appear]
Results of long term acoustics series (Polar ecosystem, Hudson strait - 2011, collaboration with ministry of fisheries & oceans, Canada)

Links between polar marine mammals ecology
And Sea Ice

Number of acoustics detection per day

Humback Whale (mate finding song)

Beluga (social calls)

Bearded seals (mate finding calls)

Ice coverage

[Credit C. Gervaise et al. 2013-2015, to appear]
Conclusion: Several spatial scales are needed to analyse marine soundscapes.

- **Micro scale**
  - Acoustics
  - 1m x 1m
  - Individual, species

- **Meso scale**
  - Acoustics
  - 1km x 1km
  - Communities, habitats

- **Macro scale**
  - Acoustics
  - 100 kms x 100 kms
  - Biodiversity, Ocean Basin
A multi-purposes platform for *in situ* μ-acoustics GIPSA + LSIS + PNPC + Lyon. eau

An array of hydrophones
- To measure the sound production
- To identify which sounds come from the inside of the array (vs the outside of the array)

An array of camera
- To describe the ground truth inside the array
- Species, activities, behaviours
3.8 Collaborative Plateforms
SABIOD BOMBYX Observatory – Univ. Toulon, near Port Cros – 2014 – 2017...
Application transient analysis on Physeter (cachalot) recorded on BOMBYX 2014
Distance estimation using only one hydrophone [Doh et al 2014]
2 years activity of the antartic mink whales
=> need of clustering / indexing
See the proceedings of SABIOD workshop at NIPS4B

Credit Lars Kindermann, NIPS4B
3.9 BAT Monitoring with Cyberio SA
Robust to different species, chirp, voicing,...
Maturation of LSIS USA patent at Cyberio (2013-14) :

Real bat trajectory computed by Toulon univ. LSIS
CNRS SABIOD.ORG & SATT projects
(Pipistrellus sp. record Cyberio, Grenoble Fr)
Coming in 2015

BIG DATA CHALLENGES; Ma ville, Mes chauves-souris
Focus on **Brazil** area
Most populated country in XC dataset
1st country in terms of **endangered species**

**14027 recordings** from the **top-501 species**
minimally 15 recordings per species (max 91)
minimally 10 different recordists per species (max 42)

**Metadata:**
- type of sound (call, song, alarm, etc)
- day + time
- location + gps + elevation
- recordist & personal remarks
- quality rate
**BirdCLEF: Task**

**Event-based split** *(2/3 vs. 1/3)*

**Foreground & background species**

Numerous audio records are associated with some background species in the metadata.

But most of them focus on one single bird recorded with a directional microphone.

**Training Set**

<table>
<thead>
<tr>
<th>Test recording 2</th>
<th>Test recording 238</th>
<th>Test recording 490</th>
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<tbody>
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</table>

**Metric = Mean Average Precision**

same day, same time, same place, same device, same species
Life Clef 2014
Large scale challenge BIRD SPECIES from Bresil
using Crowdsourcing and Crowdsolving: the largest species classification system
Places of XenoCanto recordings
Mean Average Precision of the Bird Life Clef Challenge 2014 (500 species)
3rd bioacoustic bird challenge at NIPS 2013 Biocoustics - Nevada dec.13

Task : 81 species of birds and few amphibian (Provence France), assign a probability that a given species sings at any point in a continuous short recording.
Challenging because of background noise, variability in the bird sounds, and overlapping songs.

=> 32 teams participated on Kaggle interface, Average of the AUC over the species, best = 0.92

http://sabiod.org/nip4b
4. Discussion - Conclusion

4.1 Features shall be learned: MFCC versus Feature learning (SC)

![Bar chart showing comparison between MFCC and learned features across various species.](image-url)
4.2 Towards intra animal & large scale wave modelisation

- Machine learning on synthetic and real data set

- Inverse model

- Uncertainty estimations

- Application to Physeter transients
Here the Inter Pulse Interval = 4.5 ms
Origin of the different pulses: multi-intra head reflections
HPC & bioacoustics

Physeter Head 2D – 3D modelisation

Gaussian radial impulsion

Wave equation (elasto-acoustic)

Finite element modelisation (SPECFEM)

HPC and GPU
4.3 Conclusions

- Needs of High Performance Computer

- Needs of Feature Learning for efficient classification (see unsupervised methods at ICML4 bioacoustics 2014)

- Multiscale signal decomposition and Source separation can help to label the different sources in time and frequency and help into unsupervised feature learning

- Convolutional Deep Learning will be more investigated

- Crowsourcing plateform and long term recordings

Animations: SABIOD organized conf. series on 'Machine Learning for Bioacoustics' 

2013: 
• IJCNN Dallas (Unsup. Learning) 
• ICML4B (Atlanta) Machine Learning for Bioacoustics (+ NY Univ) 
• NIPS4B (Nevada) Neural Information Processing for Bioacoustics (+UMPC & Cornell Univ & NY) 
• Kaggle challenge organizations (Bird ICML, NIPS4B bird challenge) 

2014: 
• ICMLulb2014 (Beijing) Unsupervised Machine Learning from Bioacoustic Data (+Facebook & Cornell & UPMC) 
• Ecoacoustics, Muséum Histoire Naturelle de Paris, 150 participants 
• LiFeClef lab with INRIA & Geneve univ. 

2015: 
• Int' summer School ERMITES
Neural Information Processing
Scaled for Bioacoustics
-from Neurons to Big Data-

Proceedings of NIPS4B, international workshop joint to NIPS, USA, 2013

Glotin H., LeCun Y., Artières T., Mallat S., Tchemichovski O., Halkias X.
Toulon, New-York, Paris


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Aim and Scope

The general topic of uLearnBio is probabilistic machine learning from bioacoustic data. It mainly focuses on unsupervised learning from bioacoustic data. Unsupervised learning approaches aim at automatically acquiring "knowledge" from data for representation, analysis, etc. One of the main goals in unsupervised learning is clustering/segmentation. Clustering is indeed one of the essential tasks in statistics and machine learning and one of the most popular and successful approaches in cluster analysis is the mixture model-based clustering approach. The model-based clustering approach is known by its well-established theoretical background and the associated efficient estimation algorithms such as Expectation-Maximization algorithms. The problem of selecting the number of mixture components can be tackled thanks to model selection criteria such as BIC, AIC, ICL, etc.

Another probabilistic alternative for cluster analysis is the one based on Bayesian Non-Parametrics (BNP), in particular the Infinite Gaussian Mixture Model (IGMM) formulation, Chinese Restaurant Process (CRP) mixtures and Dirichlet Process Mixtures (DPM). The non-parametric alternative avoids assuming restricted functional forms and thus allows the complexity and accuracy of the inferred model to grow as more data is observed. It also represents an alternative to the difficult problem of model selection in model-based clustering models by inferring the number of clusters from the data as the learning proceeds. One the main current concerns for all these approaches which are confronted with the big data problem, is to scale them up.
ICML 2013 Workshop on Machine Learning for Bioacoustics
June 16-21, 2013 - Atlanta, Georgia, United States
Green machine learning

Workshop Chairs:
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Bioacoustic signaling is a primary mode of communication and exploration for most of the animals. It enables quick load and transfer of information without any visible contact with the target, tackling the reduced visibility of deep forest (insect, frogs, birds, mammals...), cave or night activities (insects, bats), and/or the long distances like in ocean (krill, fishes, whales...). Bioacoustics is also one of the factors in optimizing natural selection, playing a significant role in signalling resource qualities to potential partners. The SABIOD project aims to detect, cluster, classify and index bioacoustic big data in various ecosystems, at different space and time scales, in order to reveal informations on the complex sensori-motor loop, and on the health of an ecosystem, yielding to new biodiversity insights.

NEWS:
- ICML 2014 workshop opens : We are pleased to inform you that paper submission is now open for our ICML 2014 workshop uLearnBio: "Unsupervised Learning from Bioacoustic Big Data" joint to ICML, 21-26 June 2014 in Beijing, China.

- LifeCLEF 2014 Bird Identification Task - Training Data Release We invite you to participate in this new Bird Identification challenge, based on different types of audio records over 500 species from South America centered on Brazil (14027 audio records, 9688 train+4339 test). This challenge is the biggest ever organized, after the pioneer ICML 2013 and NIPS 2013 bird challenges that dealt 'only' with less than one hundred of species but interested many teams. Listen here to a sample of the LifeClef challenge.

- Book of the int. workshop Neural Information Scaled to Bioacoustics NIPS4B, from neurons to big data - Nevada

- Book of the 1st international congress Machine learning for big acoustic ICML4B - Athens
SABIOD Results Summary 2012-14

- 5 book chapters, 7 journal papers, ~12 papers in conferences ( sabiod.org/publications.html )
- 2 collaborative Phd Theses (LSIS LAM def. 2014, CIBRA LSIS def 2013)
- 4 int. Workshop in Machine learning on bioacoustic data ( ICML 13 Atlanta, ICML 14 Beijing, NIPS 2013, NIPS 2015 ?...)
- Patent Licencing ; Price from minist. ecology dec 2014 with Cyberio & EGIS

Actions 2015...

- Support of young researchers (benchmarks, toolkits, Master Dauphine, ENS)
- 2 expected Phds (LAMFA & LSIS), (LSIS & ENS Paris)
- JASON project UTLN / PACA : 30 perm. signal / transmission sabiod.org/jason
- Summer school ERMITES 15 on bioacoustic data science glotin.univ-tln.fr/ERMITES15
- Glotin is Pr invited at ONCanada and Orca Lab ; Pavan is Pr invited at UTLN
- Expositions (aquarium Paris 2016)
- Project Eu H2020 / Feder Alpes Inter Reg
- Pelagos Projects : VAMOS = ANTARES + Bombyx 2015-17
- ONCET at Orca Lab 2015-16
- New Caledonia Humpback monitoring 2015-16
- Continuation of Madagascar BAOBAB project 2015-16
2015: SABIOD ONLINE CETACEAN TRACKING (US patent) at ORCAL LAB Victoria univ.

VHF Hydrophone positions = red dots
LOCUSONUS + JASON: crowdsourcing en ligne / Aix / Ventou.... Africa/ Australiia
HERACLES project
Lagon Sud, New Caledonia - Unesco
Real time whale anti-collision avoidance, 2013...
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