EthoAcoustics : a model based on t-SNE & Clustering, ap-plied on Pantropical spotted dolphin during Whale Watching

Marion Poupard, Benjamin de Montgolfier, Vincent Roger, Devashish Lohani, Hervé Glotin

HAL Id: hal-01873336

https://hal.science/hal-01873336

Submitted on 13 Sep 2018

EthoAcoustics : a model based on t-SNE & Clustering, applied on Pantropical spotted dolphin during Whale Watching

Marion Poupard[1,4], Benjamin de Montgolfier[2,3], Vincent Roger[1,2,5], Devashish Lohani[1,2], Hervé Glotin [1,2]

(1) Univ. Toulon, Aix Marseille Univ., CNRS, LIS, DYNI, Marseille, France; (2) EADM GDR MADICS; SABIOD.org; (3) Aquasearch, Martinique, France; (4) Biosong, France; (5) NortekMed, France

1. Introduction

Acoustic monitoring is used to study marine mammals in ocean, to understand their behavior, movement or reproduction. It is a low cost and non invasive method, as long as it can be fully automatized. Automated analysis for captured sound is very essential because records are very large in size and dimensions, making them almost impossible to analyse manually . The objective of this work is to demonstrate a correlation between swimming behavior and bioacoustics of cetaceans. We then develop an integrated method of analysis, treatment and interpretation of bioacoustical and ethological data sets, that we call "ethoacoustics".

The increase of maritime traffic, water scooter (jet ski) and whale-watching in the Caribbean Sea have consequences on marine life. Currently, 25 companies of whale watching are present on the coast of Martinique. Pantropical spotted dolphin (*Stenella attenuata (Sa)*) is the most observed marine mammal species in this area. Thus it has been selected for this study to demonstrate the influence of nautical tourism on it.

2. Recording Pantropical Dolphin

Recordings were done between 2013 and 2017, at mornings of the West coast of Martinique (hydrophone H2a-XLR Aquarian, at -15 m, handy recorder, WAV 44.1 kHz SR). When a group of cetaceans was detected, a respectful approach was used. The behavioral state of dolphins have been collected by expert observers (Socialisation, Harassment, Move, Rest and Hunting).

## 3. Whistles Tracking and Analysis

Spectrogram analysis for two days and a half of recording have been manually conducted, for a total of 489 Pantropical spotted dolphin whistles. Then they were tested (Kruskal-Wallis). It is then shown that **during socialization and harassment, final frequencies are statistically different from other behaviors**.

We also develop an automatic method for selection and categorization of whistles. This **time frequency tracker** allows to increase data sampling and thus reduce human bias. It binarizes each pixel of the time-frequency plan, resulting into continuous trajectories (= whistle). The features of these tracks are then projected in lower dimensions and clusterized.
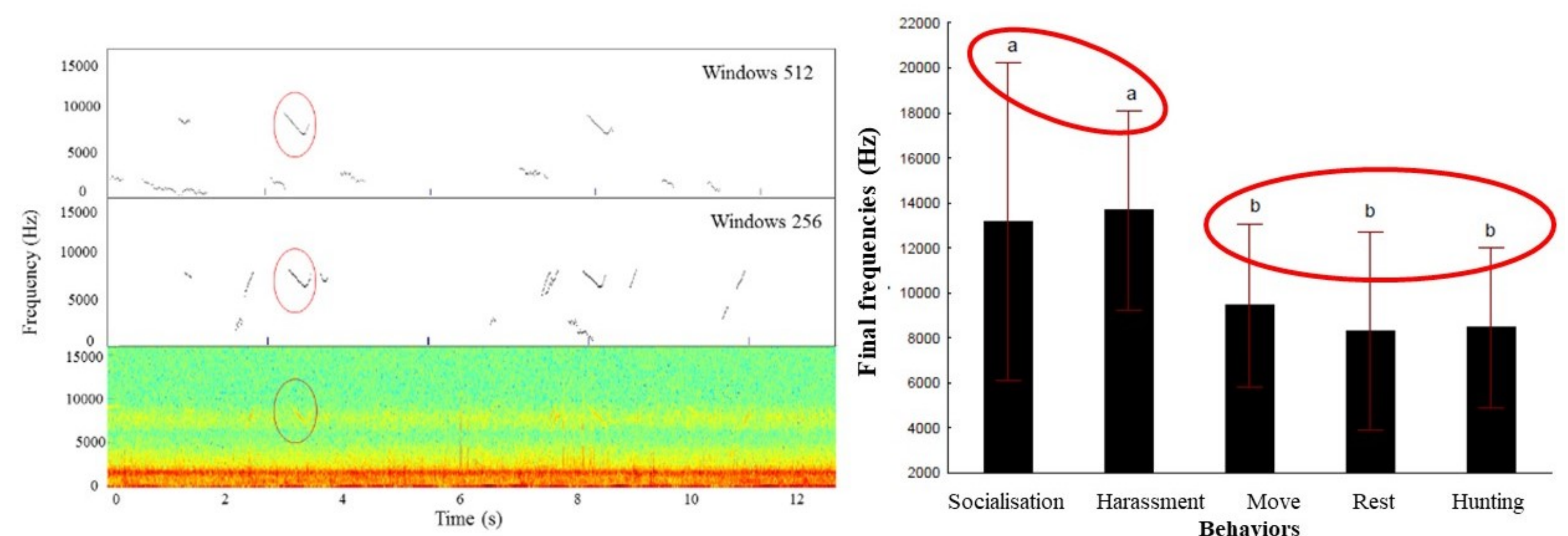
4.Ethoacoustic mapping by t-SNE

Fifteen acoustic descriptors are extracted automatically from each whistle. We project them into lower dimension (2D) space using t-SNE (T-distributed Stochastic Neighbor Embedding) [1]. Here t-SNE is better suited for dimensionality reduction than Principal Component Analysis, because of its nonlinearity. Then each whistle's coordinates in the t-SNE space are clusterized by Bayesian Non-Parametric clustering (BNP). We finally measure the quality of the resulting clusters by Normalized Mutual Information scores (NMI), to quantify the correlation between **acoustical and ethological observations [2]**.
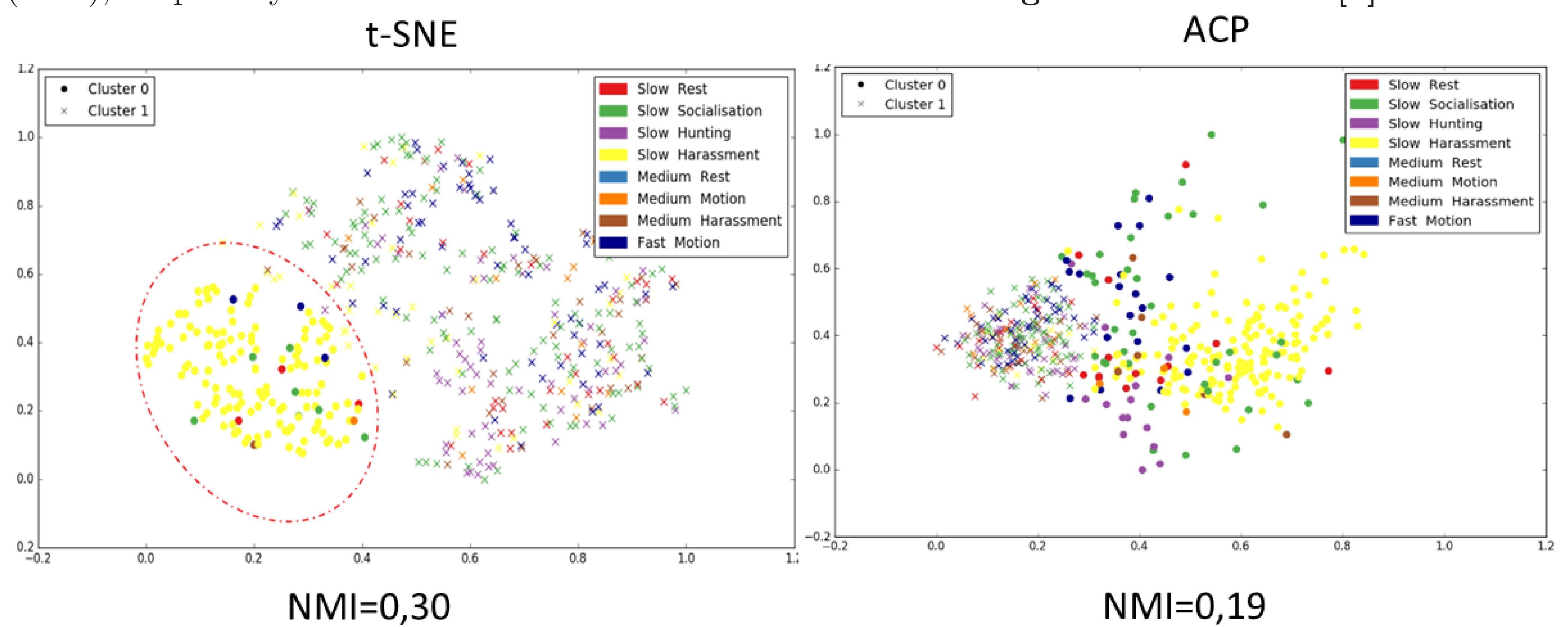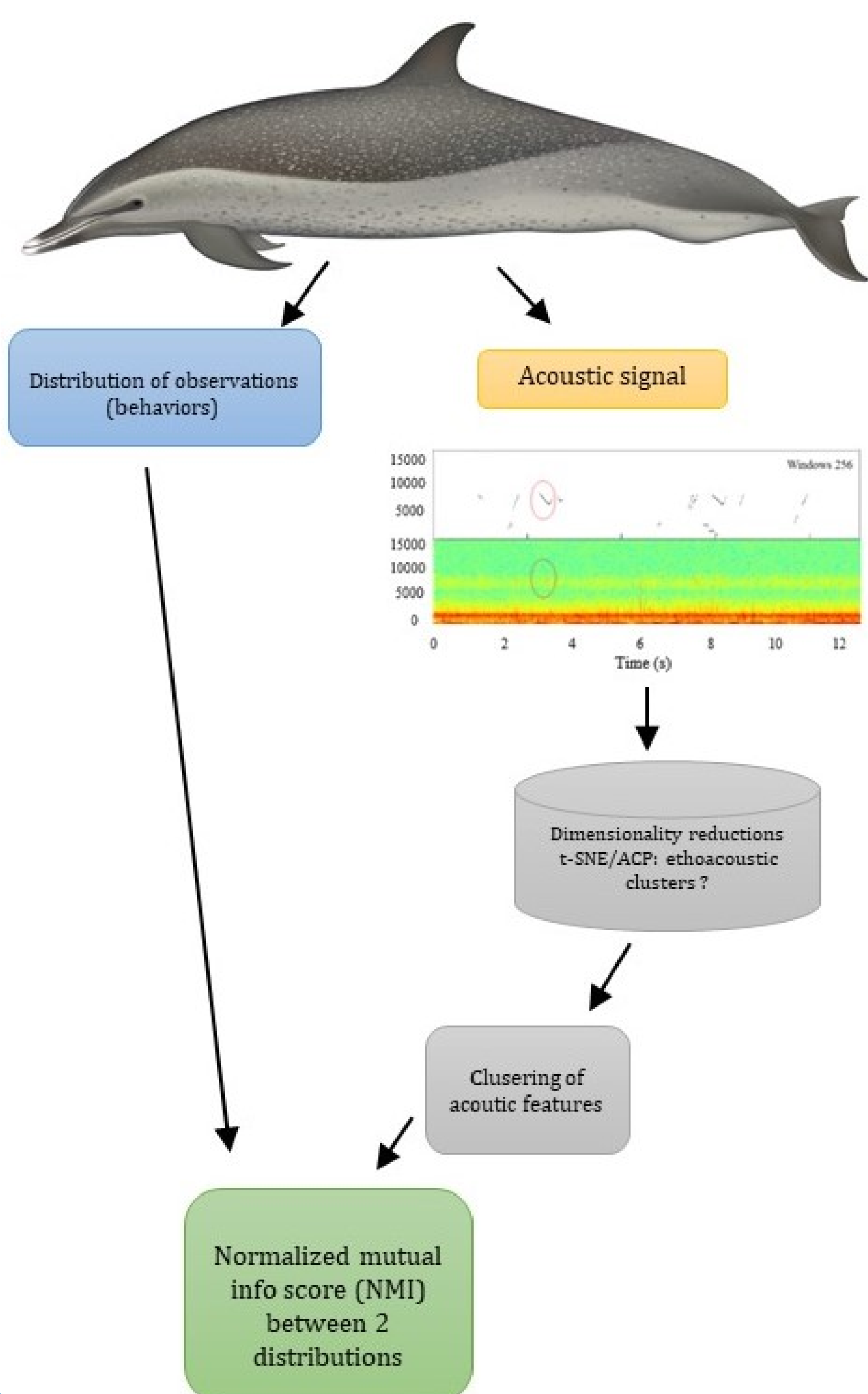
5. Discussion and Conclusion

Acoustic emissions in harassment and socialization are different from other behaviors.

1. Manual whistle identification is time-consuming and source of error.
2. Our fully automatic method is efficient.
3. t-SNE (0.30 NMI) is required for ethoacoustical modeling (compared to the NMI of linear PCA=0.19).

6. References

[1] Van der Maaten.L and Hinton. G. Visualizing non-metric similarities in multiple maps. *Machine learning*, 87(1):33–55, 2012.

[2] Poupard. M, Glotin. H, Bouchard. B, De Montgolfier. B, Lohani.D, Roger.V, and Celerier. A. Automatic ethoacoustics : t-sne & bnp merging acoustical & ethological observations - app. on spotted dolphin & humpback whale. dyni lis rr. 2018.

Scan me!