DEEP SEA EXPLORERS

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Large research infrastructures have opened new observational windows, allowing us to study the structure of matter up to the entire Universe. However, society hardly observes these developments through education and outreach activities. This induces a gap between frontier science and society that may create misconceptions about the content, context, and mission of public funded science. In this context, the main goal of the European Union's Horizon 2020 "Science with and for Society" REINFORCE project (REsearch INfrastructure FOR Citizens in Europe) is to minimize the knowledge gap between large research infrastructures and society through Citizen Science. A series of activities is being developed on the Zooniverse platform, in four main fields of frontier physics involving large research infrastructures: gravitational waves with the VIRGO interferometer, particle physics with the ATLAS detector at LHC, neutrinos with the KM3NeT telescope, and cosmic rays at the interface of geoscience and archeology. Using real and simulated data, Citizen Scientists will help building a better understanding of the impact of the environment on these very high precision detectors as well as creating new knowledge. This poster describes the Deep Sea Hunter demonstrator, one of the sub-projects of REINFORCE involving the KM3NeT neutrino telescope, in order to show practical examples of Citizen Science activities that will be proposed through the project.

ZOONIVERSE REINFORCE

The REINFORCE project (https://reinforceeu.eu/) has started on December the 1st 2019.

Its goal is to minimize the knowledge gap between Large Research Infrastructures and Society through Citizen Science:

1. Change in awareness and understanding of basic research and its impact on society
2. Development of new knowledge and innovations by citizen
3. Availability of evaluation data concerning societal, democratic and economic costs and benefits of citizen science
4. Indicators to measure the impact of citizen science activities

Goal: Involve more than 100,000 Citizen Scientists!

Each science work package (WP) is proposing classification activities on real data from their related experiment in the Zooniverse platform.

SCAN ME

KM3NeT

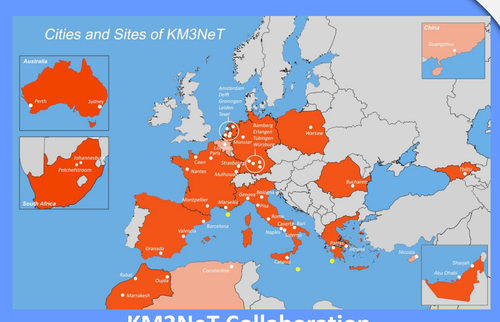
Deep Sea Explorers

- Perform completely new studies of bioluminescence and bioacoustics at the bottom of the sea and to have a better understanding of noises in KM3NeT data.

Context: Kilometer Cube Neutrino Telescope

- KM3NeT is a 3D array of PMTs* at the bottom of the sea, used to capture Cherenkov light.
- Completion foreseen in the Mediterranean Sea in 2025/2026
- ORCA* will study neutrino properties such as the Neutrino Mass Hierarchy (E ~ GeV)
- ARCA* will do neutrino and multi-messenger astronomy (E > TeV)

Citizen Scientists will help us studying bio-activity in the deep sea with KM3NeT data! Thanks to them, we will also better understand what is a source of noise in our detector, making our search for neutrinos easier!



KM3NeT Collaboration

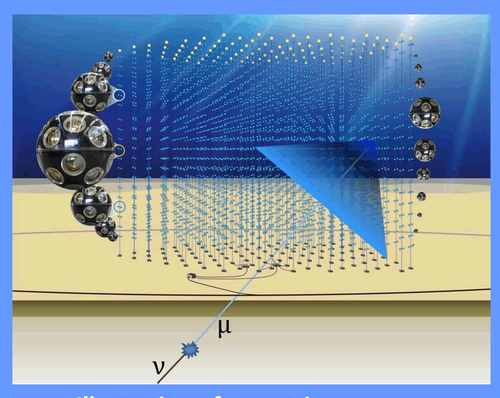


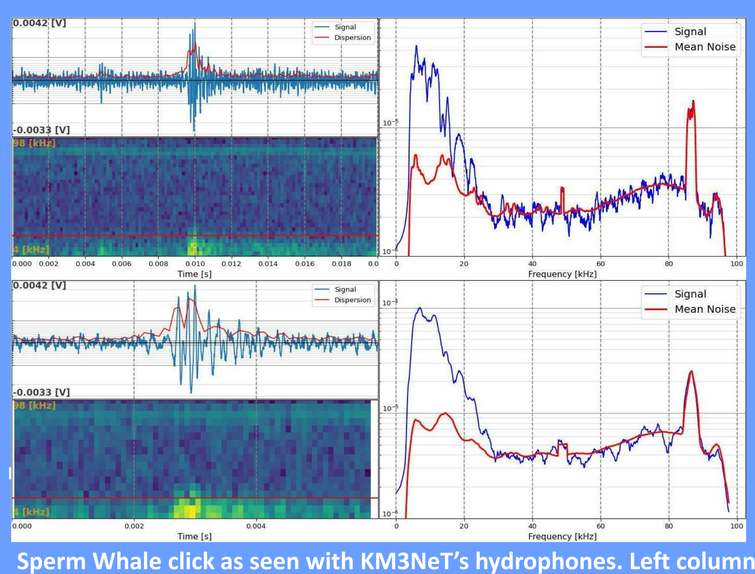
Illustration of a neutrino event

BIOACOUSTIC

We can use KM3NeT hydrophones to detect cetaceans!

Proposed activity in Zooniverse :

- Classification of cetacean clicks* by the volunteers.



Sperm Whale click as seen with KM3NeT's hydrophones. Left column : waveform of the detected signal. Right column : Associated power spectrum. Bottom row : Zoomed version.

Main purpose of this activity :

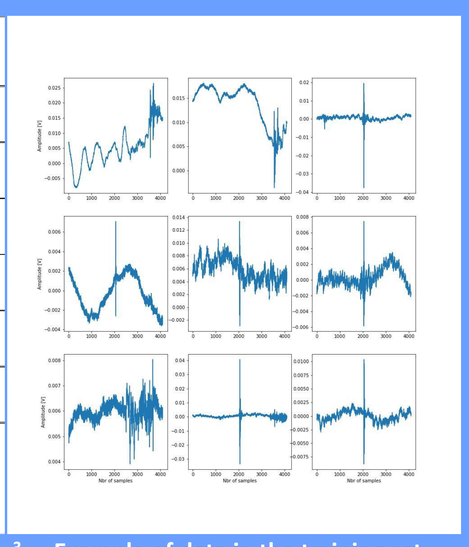
- Make a citizen scientist-machine learning comparative study.
- The data on Zooniverse are the signals that have been classified with less than 70% accuracy by the implemented neural network.
- With the help of the citizens we will therefore be able to enhance the automatic classification of ceteceans using neural networks.

1st step : Implement and train a convolutional neural network (CNN) on multiple examples :

Layer name	Input size	Kernel	Strides	Out features
Conv-1D	$N * 4096 * 1$	3	1	32
Conv-1D	$N * 4096 * 32$	3	2	32
Skip	$N * 4096 * 1$	1	2	32
Conv-1D	$N * 2048 * 32$	3	2	64
Conv-1D	$N * 1024 * 64$	3	2	128
Skip	$N * 2048 * 32$	1	4	128
Conv-2D	$N * 1024 * 128 * 1$	3*3	1*1	32
Conv-2D	$N * 1024 * 128 * 32$	3*3	2*2	32
Skip	$N * 1024 * 128 * 1$	1*1	2*2	32
Conv-2D	$N * 512 * 64 * 32$	3*3	2*2	64
Conv-2D	$N * 256 * 32 * 64$	3*3	2*2	128
Skip	$N * 512 * 64 * 32$	1*1	4*4	128
Conv-3D	$N * 128 * 16 * 128 * 1$	3*3*3	1*2*1	32
Conv-3D	$N * 128 * 8 * 128 * 32$	3*3*3	2*2*2	64
Skip	$N * 128 * 8 * 128 * 1$	1*1*1	2*4*2	64
Conv-3D	$N * 64 * 4 * 64 * 64$	3*3*3	2*2*2	128
Conv-3D	$N * 32 * 2 * 32 * 128$	3*3*3	2*2*2	256
Skip	$N * 64 * 8 * 64 * 64$	1*1*1	4*4*4	256
Softmax	$N * 16 * 1 * 16 * 256$	16*1*1		
MaxPool	$N * 16 * 1 * 16 * 256$	16*1*1		
Flatten	$N * 1 * 1 * 16 * 256$			
Dense	$N * 4096$			1024
Dense	$N * 1024$			512
Dense	$N * 512$			7

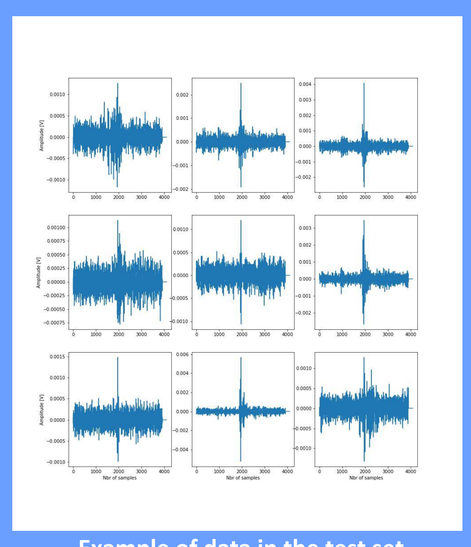
Architecture of the Neural Network.[3]

3 : M.Ferrari, H.Glotin et al. (2020)



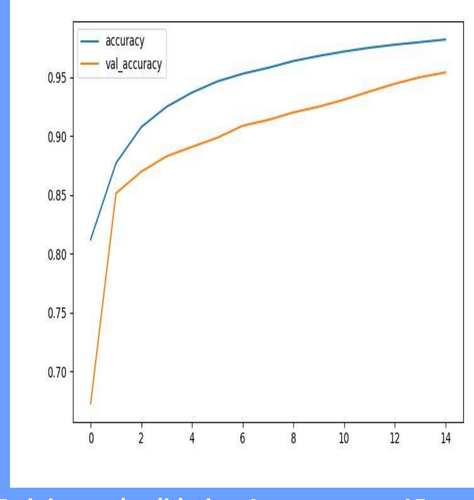
Example of data in the training set.

2nd step : Get and process the data from Zooniverse for comparison.

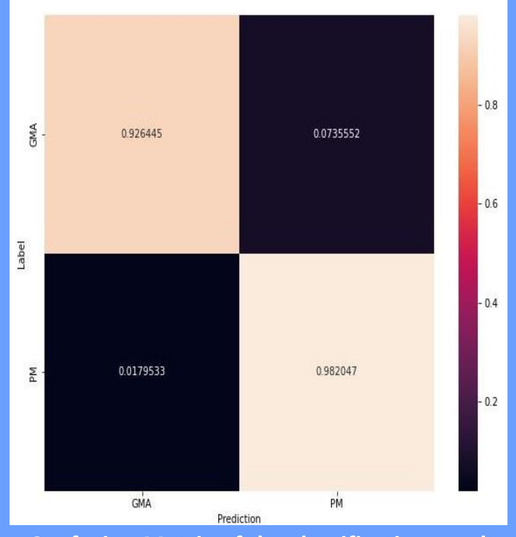


Example of data in the test set.

Last step : Compare the predictions of the neural network with the classifications of the citizens.



Training and validation Accuracy over 15 epochs.



Confusion Matrix of the classification results.

*ORCA : Oscillation Research with Cosmics in the Abyss

*ARCA : Astronomy Research with Cosmics in the Abyss

*Click : Short sound wave

*PMT : Photomultiplier Tube

*WP4 : Work package n°4 of REINFORCE

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