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A Framework for Bird Song Detection, Recognition, and Localization using Acoustic Sensor Networks

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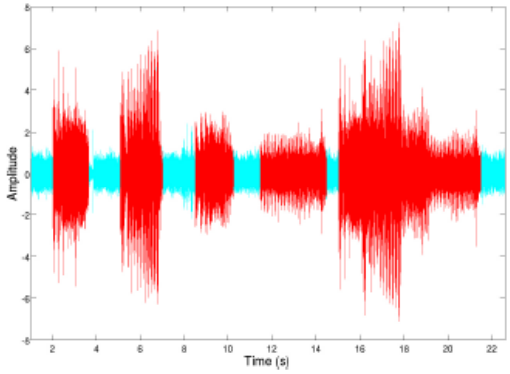
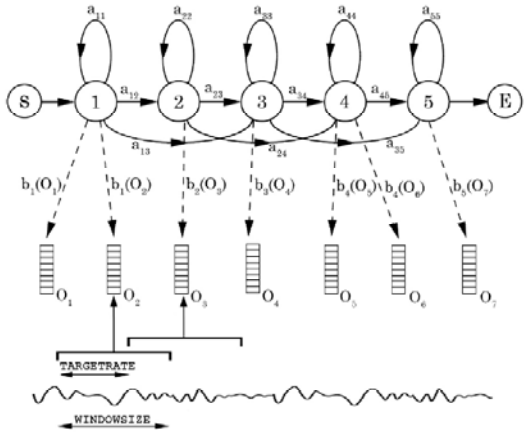
An important question in biology that remains unanswered is the role of animal communication, how and why it emerged, why does it evolve differently even for individuals of the same species, and what factors affect language evolution. To answer this question, this report presents my contribution to an interdisciplinary project whose goal to shed some lights on the mysterious mechanisms underlying avian communication. Because our focus is to understand all the factors that could have an influence on language evolution in natural habitat, we need non-intrusive tools that allow to record and analyze bird songs so that human influence is minimized.



Waveform of a recording with the results of the bird song detection procedure: the dark areas correspond to the detected birds songs.

For this purpose, we think that the very active field of sensor networks might provide us ideal platforms to record and process data because of their characteristics that make them suitable for habitat monitoring. In the meanwhile, their distributed aspect allows the correlation of environmental factors with bird behavior as no other tools commonly used by biologists allow. Besides, as we want to understand the role of social behavior in the avian language evolution,



Hidden Markov Models Main interface of the Matlab package we created

I have shown that tools derived from human speech recognition can be applied with very good results to recognize bird species and even individuals in real-time. Also, I presented and analyzed algorithms that can be used to localize birds and track their interactions in very noisy environments, as for example equatorial rain-forests. Also, I experimented the framework I have developed with data recorded with sensor networks, and show how we can detect efficiently bird vocalization from continuous recordings.

We hope that this project will open perspectives towards novel wildlife monitoring methods that scientists studying animal communication will appreciate for the drastic reduction of time and human effort our tools will allow. However, the design of such tools is a complex task, and requires a wide range of expert knowledge in many different fields.