Abstract

Animal language may be regarded as a complex adaptive system. Although there is software for identifying linguistic units or “phrases” in animal vocalisations, packages for analysing the grammatical properties of phrases sequences are scarce. PajaroLoco is an open-source Mathematica package for the study of these features.

This is a demonstration of the use of PajaroLoco with the intention of showing how PajaroLoco could be used for other network analysis tasks in the artificial life community.

Bird’s songs annotation steps

1. We start with bird’s song segmented into phrases. These phrases are the fundamental units in which the analysis will take place (the network’s nodes).

2. Then we calculate the Markov and transitions frequencies matrices. With these representations we can start analysing and calculating properties of the system such as transient states, recurrent classes, etcetera.

3. We can also obtain the network representation of these matrices. Graphs allow us to obtain measures such as centrality, “small-worldness”, clustering, mean path length, etcetera; which are relevant to many fields besides the animal linguistics one. Some videos with audio of this process can be seen by scanning the QR code next to this text.

4. In the specific case of animal linguistics displaying the phrases and communities with respect to their appearance in the song is also a good way to observe the behaviour of the language.

5. And finally we can also display the network’s degree frequency, probability and cumulative probability distribution. This is also important in various fields as it can be used as a criterion to decide whether a network is uniform, “small-world”, scale-free, etcetera; which has different implications in different fields.

Conclusions

Analysing animal language is important from a computational and complex adaptive systems point of view. Previous studies have shown that different varieties of bird songs can be compared with complex systems such as the ones generated by cellular automata. PajaroLoco is a tool developed for that purpose but although its main application is intended to be the analysis of annotated animal vocalisations, the package presented here can be used for the study of other complex adaptive phenomena in artificial life research, specially in those applications where phenomena can be described as sequences of elements and are amenable to network analysis.

1. Record song
2. Transfer song to computer
3. Analyse the spectrograms to differentiate phrases
4. Use PajaroLoco for analysis!