CARAT: COMPUTER–AIDED RHYTHMIC ANALYSIS TOOLBOX

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EXTENDED ABSTRACT

CARAT is a toolbox for computer–aided rhythm analysis from audio recordings that includes a set of ready-to-use tools in order to maximize its usability. It was developed in Python, using NumPy, SciPy, Matplotlib, and Scikit-learn libraries, and is released under the MIT licence.[1] This toolkit aims to ease the adoption of computational tools by musicologists, while at the same time making readily available to MIR researchers some recently developed techniques for rhythm analysis, along with musical examples of their applicability.

To meet these goals, some aspects were prioritized in the design. Since we strive for a low barrier to entry for researchers in musicology with no background in scientific programming, the toolbox provides some applications that allow the analysis of individual audio files or collections of music data, enabling some interaction with the user (e.g., visualization and listening). The choice of free, open-source and cross-platform developing tools also contributes to a wider accessibility. Besides, functions and processes were designed to be modular, thus allowing users to provide their own functions or to test other work flows for the analysis.

This work is part of an interdisciplinary collaboration for the development of computer-aided tools for analysis of musical rhythm, addressing onset detection/classification, automatic beat/downbeat tracking and others.

The toolbox includes functions/applications to deal with rhythmic pattern analysis [4]. This involves computing an accentuation feature from the audio and organizing it into a map of cycle-length rhythmic patterns, which enables the inspection of similarities/differences between patterns, and their evolution over time. Through a process supervised by the user, the rhythmic patterns can be automatically clustered into groups. Results from different recordings can be aggregated for the analysis of a music collection [3, 9].

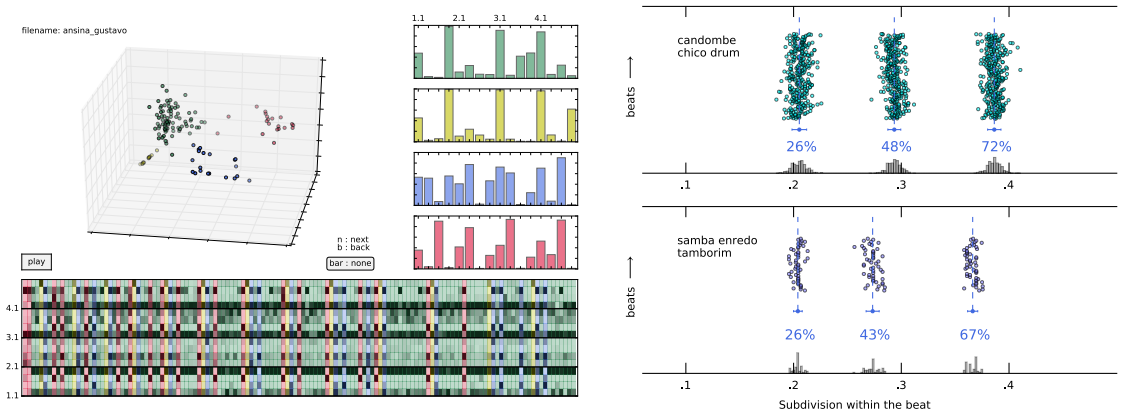
The toolbox also allows the analysis of micro–temporal deviations of the rhythmic patterns with regards to a regular metrical grid, based on onset and beat locations—either automatically detected or available as annotation files [7]. Deviations of the onsets normalized according to the length of the beat or the rhythm cycle are analyzed [2].

Pieces from three different corpora were taken as case studies: Uruguayan candombe drumming [5, 10], Brazilian samba [1, 6] and djembe music from Mali [8]. These three corpora belong to the broad category of percussion music of the Afro–Atlantic tradition and share some common characteristics, although they also have important differences, like different cycle lengths or beat subdivisions. The tools provided in the toolbox should be able to manage such differences.

Figure 1a shows the clustering analysis of the patterns of the piano drum in a recording of Uruguayan candombe. The map of cycle–length patterns is depicted at the bottom, and the three–dimension representation corresponds to an Isomap mapping. The centroid of each cluster is shown at the right; the obtained clusters match characteristic patterns of the instrument. The program interface allows the user to listen to individual patterns by selecting them on the image, and the number k of clusters can be interactively adjusted [9].

[1] https://carat.readthedocs.io https://github.com/mrocamora/carat

Figure 1b shows a comparative analysis of microtiming in the patterns of the chico drum in candombe and the tamborim in Brazilian samba. Both instruments articulate four pulses per beat, shown here along a beat–normalized axis. Both patterns exhibit different degrees of compression with respect to an equal subdivision of the beat [2].



(a) Map of piano drum patterns

(b) Comparison of microtiming in chico and tamborim

Figure 1

ACKNOWLEDGMENTS

This work was partially funded by the following agencies: CSIC and ANII from Uruguay, CAPES and CNPq from Brazil, AHRC from the United Kingdom, CNRS and STIC-AmSud program from France.

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