

# Moving in Time: Computational Analysis of Microtiming in Maracatu de Baque Solto



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## Maracatu de Baque Solto

- Carnival practice in rural Pernambuco in North Eastern Brazil
- Performances comprise short alternating periods of improvised poetry followed by music and dancing
- Performances can last several hours
- Musicians play as loud and fast as possible and in close proximity
- Maracatu de Baque Solto is a very localised musical practice that has not been widely studied
- Our work is part of the multidisciplinary project: “HELP-MD: The Healing and Emotional Power of Music and Dance” <https://www.help-md.eu>

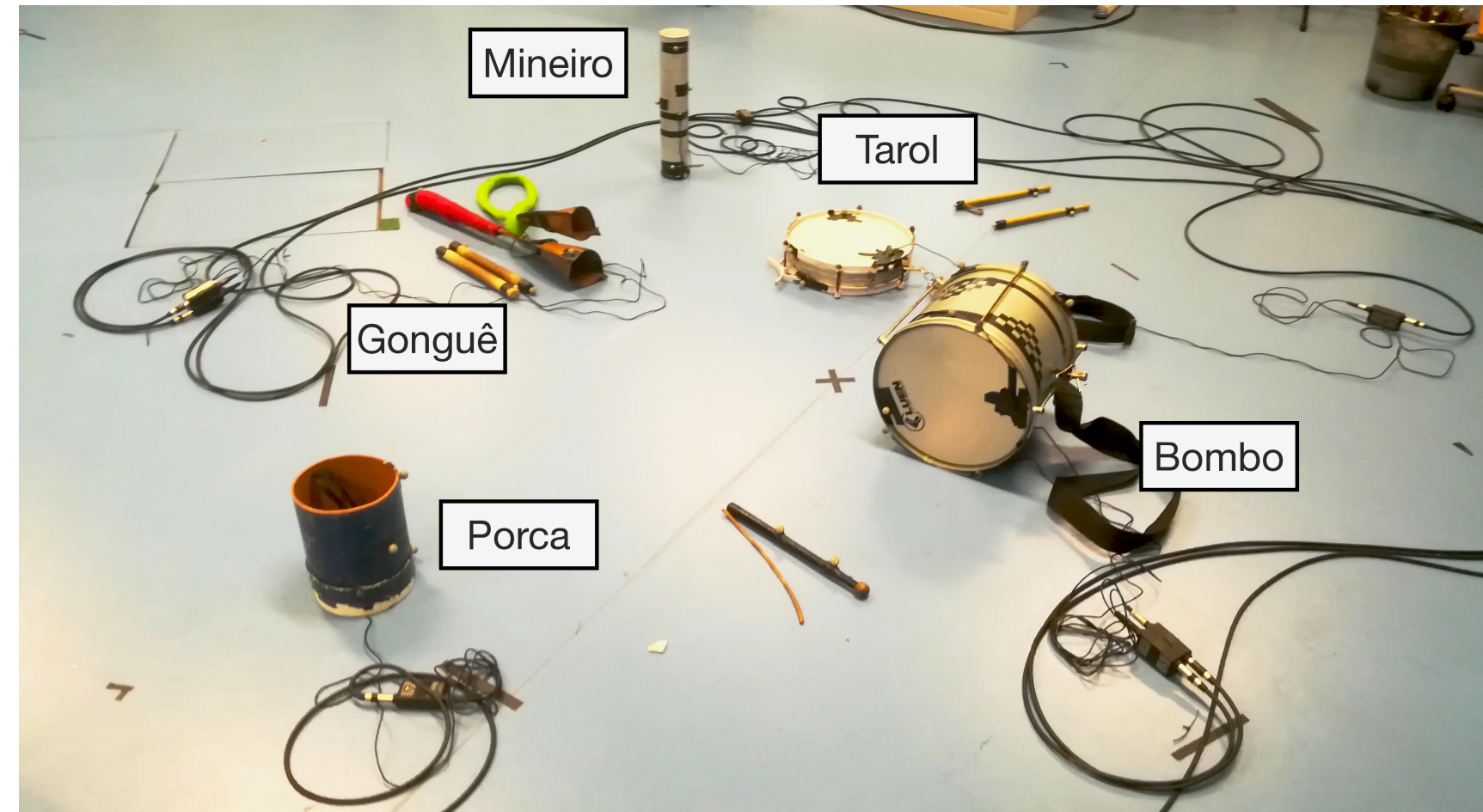


## Motivation and Objectives

- Longer term:** Understand how maracatu performance promotes health and well-being, in relation to the concepts of “consonância” (consonance) and “fechar o maracatu” (to close the maracatu)
- Shorter term:** Study the presence and nature of microtiming in maracatu
  - Devise a methodology for isolated signal acquisition
  - Manually annotate the onset and beat structure
  - Estimate continuous microtiming profiles relative to time-keeper instruments
- Conduct the work from a **strongly multidisciplinary perspective** which leverages connections between ethnomusicology, audio engineering, music signal processing and machine learning

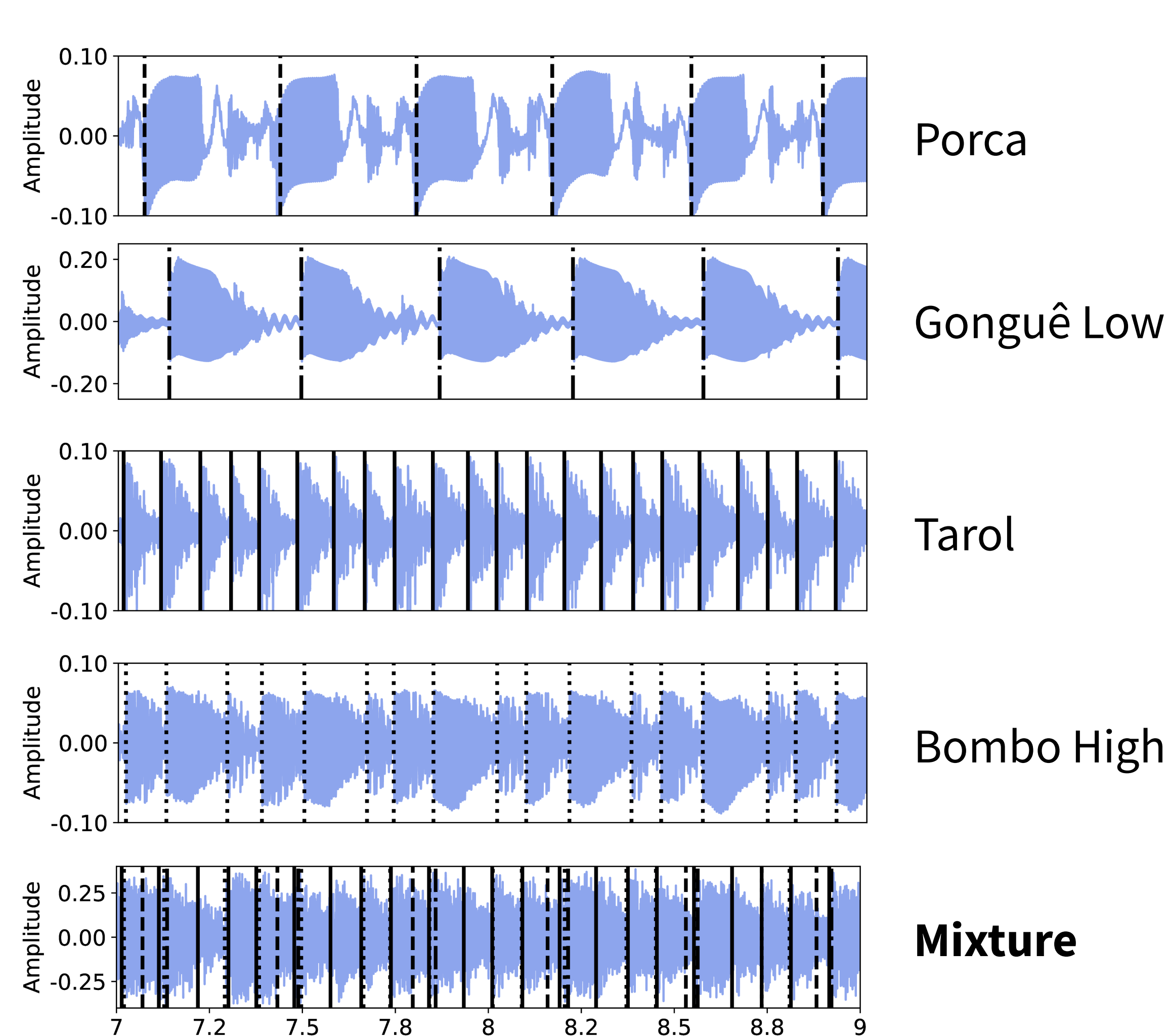
## Signal Acquisition with Contact Microphones

- Focus on the analysis of the “terno”
- Contact microphones were attached in an unobtrusive manner on each of the five instruments
- 1x Mineiro, Tarol, Porca
- 2x Gonguê and Bombo
- Multi-track recordings acquired at an outdoor, fixed location maracatu performance in Lisbon, Dec. 2019
- Additional recordings taken in the Motion Capture Laboratory (FMH, Univ. Lisbon) for multimodal analysis of music and dance



## Onset Annotation

- 34 pieces in the concert, totalling 22 minutes
- For 7 mics, this gives 238 excerpts to annotate
- We focus on two (potential) time-keepers: **porca & gonguê low** and two more expressive instruments: **tarol & bombo high**
- We used a semi-automatic process with *instrument-specific* neural networks for onset detection and subsequent manual correction
- Approximately 45,000 annotated onsets
- Often more than 20 onsets per second of the mixture
- Very hard** annotation task from mixture alone



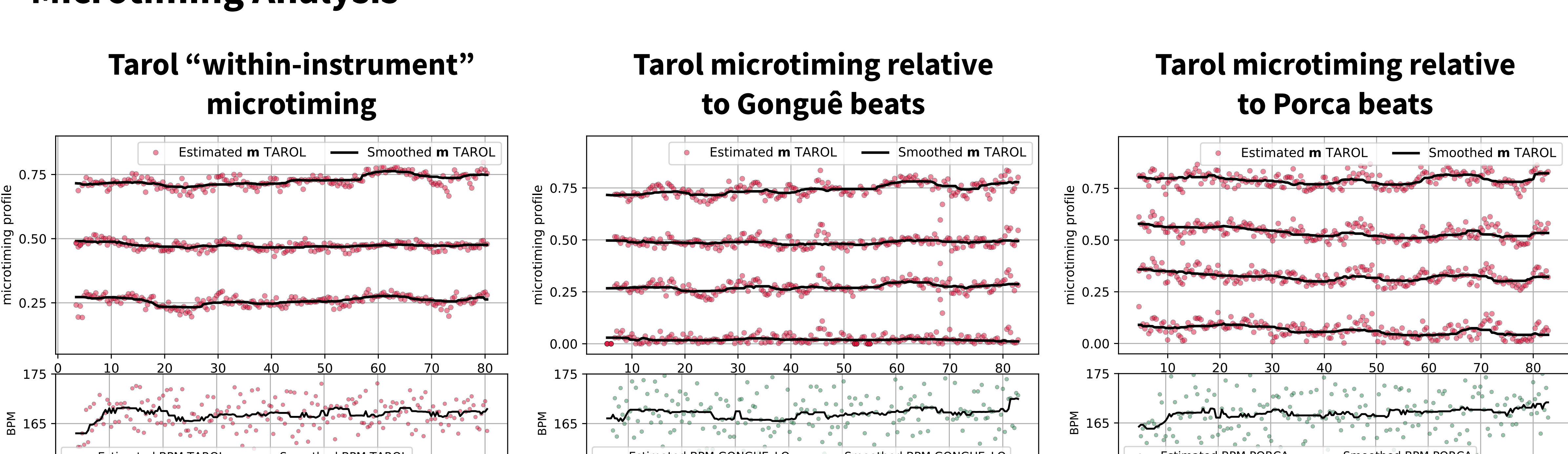
## Microtiming Analysis

- Inspired by the existing approach of (Fuentes et al, ISMIR 2019), we developed an algorithm that we feed onset times and beats
- We can perform “*within-instrument*” and “*between-instrument*” analysis
- Estimate a normalised microtiming profile per sub-division of the beat
- Look for systematic, i.e. intentional, deviations from quantised metrical positions according to Western music notation

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Algorithm 1: Microtiming modelling
Input: b, o, τ, r
Output: m, t
for i ← 1 to len(b)-1 do
    Δb ← b(i+1) - b(i);
    tini ← b(i) - τ × Δb;
    tend ← b(i+1) - τ × Δb;
    obeat ← o[tini < o < tend];
    if len(obeat) < τ and obeat is not empty then
        otemp ← range(0, 1, 1/r) + tini;
        for j ← 1 to len(obeat) do
            kmin ← arg mink (obeat(j) - otemp(k));
            ofix[kmin] ← obeat(j);
        end
        obeat ← interp(ofix[nan], ofix[~ nan])
    else
        continue;
    end
    for j ← 2 to len(obeat) do
        vIOI(j-1) ← obeat(j) - obeat(j-1)
    end
    m(i) ← vIOI / Δb;
    t(i) ← b(i)
end
    
```

## Microtiming Analysis



- Evidence of time-varying microtiming profiles which indicate a dynamic use of microtiming within pieces
- When analysing “*between-instrument*” microtiming profiles, the choice of time-keeper to provide the beat reference is important and can change the interpretation of the performance

## Conclusions

- First computational study of Maracatu de Baque Solto which suggests a dynamic use of microtiming
- Substantial effort is required to even begin to analyse microtiming in the recordings
- This work strongly depends on a multidisciplinary approach which connects:
  - ethnomusicology, audio engineering, and music signal processing
- Future work will focus on understanding the concepts of “consonância” and what it means to “fechar o maracatu” in relation to musical performance