Polyrhythmic modelling of non-isochronous and microtiming patterns

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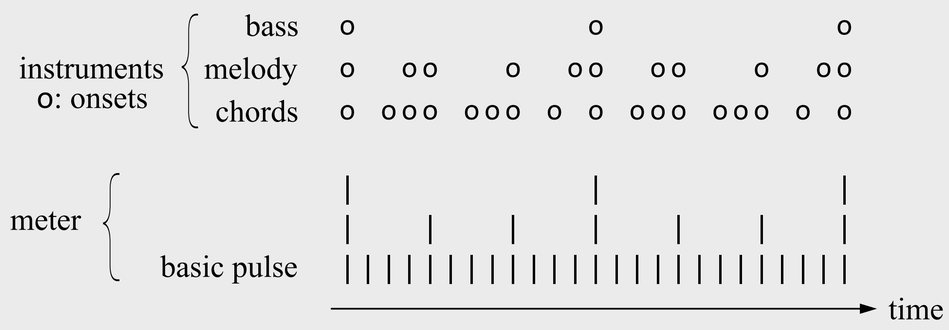
Computational models and analyses of musical rhythms are predominantly based on the subdivision of durations down to a common isochronous pulse, which plays a fundamental structural role in the organization of their durational patterns. Meter, the most widespread example of such a temporal scheme, consists of several hierarchically organized pulses. Deviations from isochrony found in musical patterns are considered to form an expressive, micro level of organization that is distinct from the structural macro-organization of the basic pulse. However, polyrhythmic structures, such as those found in music from West Africa or the African diaspora, challenge both the hierarchical subdivision of durations and the structural isochrony of the above models. Here we present a model that integrates the macro- and micro-organization of rhythms by generating non-isochronous grids from isochronous pulses within a polyrhythmic structure. Observed micro-timing patterns may then be generated from structural non-isochronous grids, rather than being understood as expressive deviations from isochrony. We examine the basic mathematical properties of the model and show that meter can be generated as a special case. Finally, we demonstrate the model in the analysis of microtiming patterns observed in Brazilian samba performances.

Background

Rhythms are typically understood at two organisational levels [1]:

1. An isochronous "structural" pulse

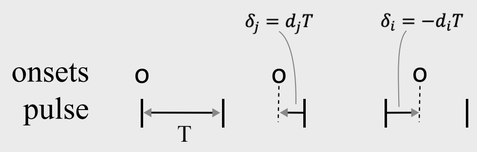
The basic isochronous pulse captures the canonical properties of the rhythm. The beats of the pulse are periodically grouped to form a metrical hierarchy consisting of several levels [2]:



A metrical hierarchy may include non-isochronous levels, but all levels share the faster basic isochronous pulse.

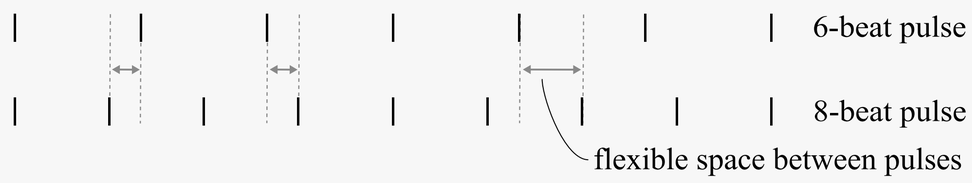
2. Expressive timing deviations from isochrony

Systematic deviations from the canonical duration of the isochronous pulse are measured in ms or as a percentage of the beat duration to facilitate comparison between different tempi.



Polyrhythmic music challenges the above hierarchical organization

Polyrhythms are organized on the basis of multiple isochronous pulses of different periods that do not coincide.



Certain polyrhythmic music also show large and systematic deviations from isochrony. In the music of the African diaspora, the intervals between the pulses of a 16|12 (or 8|6) polyrhythm define a flexible space in which events can have a 'mixed' character, belonging simultaneously to both pulses [4].

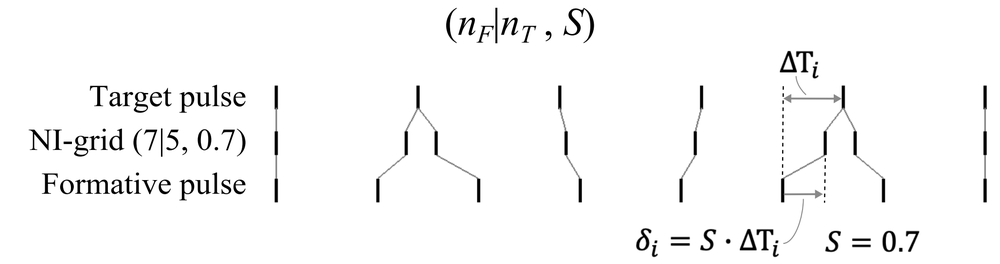
Non-Isochornous grids

Non-isochornous grids (NI-grids) bring together the isochornous/macro and the expressive/micro levels of rhythmic organisation in a single framework rooted in polyrhythms.

isochronous / macro
expressive / micro
→ polyrhythmic framework of NI-grids

NI-grids are constructed by morphing one pulse of a polyrhythm (*formative*) into the other (*target*). A NI-grid is defined by the number of beats in the formative and target pulses, n_F and n_T, and a morphing factor, S:

$$(n_F|n_T\,,\,S)$$



δ_i NI-grid beat shift from canonical pulse location
S Morphing factor
ΔT_i Distance between the beats of the two pulses

Beats of a NI-grid fall between the beats of the two pulses.

NI-grids are maximally even patterns of two beat durations

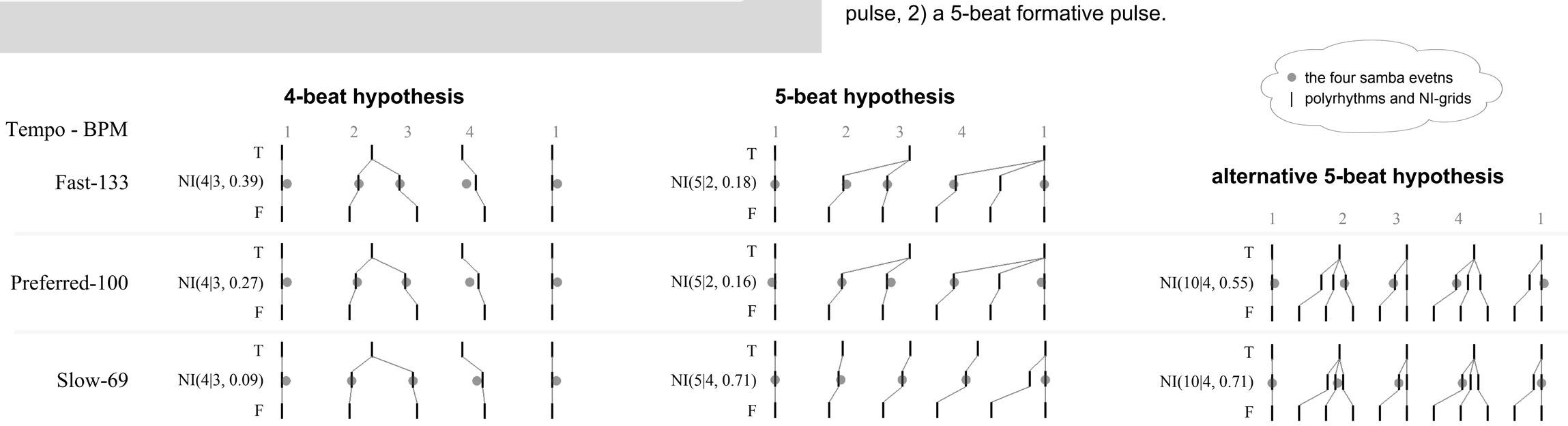
Morphing between isochornous pulses results in NI-grids of only two beat durations. A Long (L) and a Short (S) beat.

The distribution of Long and Short beat durations in NI-grids is maximally even, generalising the maximally even beat patterns produced by the Euclidean algorithm [3].

Polyrhythmic modelling of basic Brazilian samba pattern

The non-isochronous repetitive patterns of samba are considered a characteristic feature of the performances and an integral part of the style. In [5], the mean durations of the four events that make up the basic pattern were measured at three different tempi (fast, preferred, slow).

We hypothesise that the observed non-isochronous patterns are the result of an underlying polyrhythmic structure, and we attempt to reproduce them as NI-grids. We formulate two hypotheses involving 1) a 4-beat formative pulse, 2) a 5-beat formative pulse.



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