Bi-musicality in the Age of Artificial Intelligence

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The notion of bi-musicality was first introduced by Mantle Hood in his influential paper published in 1960 and this notion is still used and discussed today (Hood, 1960). The term itself, "bi-musicality", was coined on the model of bilingual, a word which is applied to somebody who is fluent in two languages belonging to different communities, and underlining how both music and language are attached to human groups or communities. Today, the term bi-musicality is now a taken-for-granted part of the ethnomusicologist's methodology (Rice, 2014, p. 21). However, in the era of globalization and post-colonial issues, some new perspectives have also arisen. When the term was first introduced over sixty years ago, what is today called World Music was not yet established. Nowadays, cultural boundaries have tended to blur and the idea of learning the music of non-Western cultures is no longer exclusively the preserve of ethnomusicologists. Furthermore, technology also raises new questions on this subject, particularly artificial intelligence and machine learning. Recent developments in computer science are beginning to give meaning to the notion of "artificial creativity" (Lubat et al., 2021). Therefore, it is natural to inquire whether a machine can also become bi-musical, and in what sense. This concert-conference explores such ideas in the case of a zither repertoire from Madagascar and illustrates them by live interaction between the computer and a Malagasy musician, the great Justin Vali.

SENSORS ON A MALAGASY *MAROVANY* ZITHER

This presentation is devoted to the repertoire of a *marovany,* a traditional zither from Madagascar. This instrument differs from the well-known tubular bamboo zither called the *valiha* because its soundboard is not a cylinder but rather a rectangular box. It is played for several hours at a time in *tromba* possession rituals. Studying the structuring of improvisation on this time scale led us to develop MIDI sensors for the zither. After testing several different pickups, we applied piezo pickups placed between the strings and the bridges. Although the *valiha* zither has already been studied by past research (Domenichini, 1984; Razafindrakoto, 1999), there are no transcriptions of the *marovany* repertoire except a few examples (Schmidhofer, 2005).

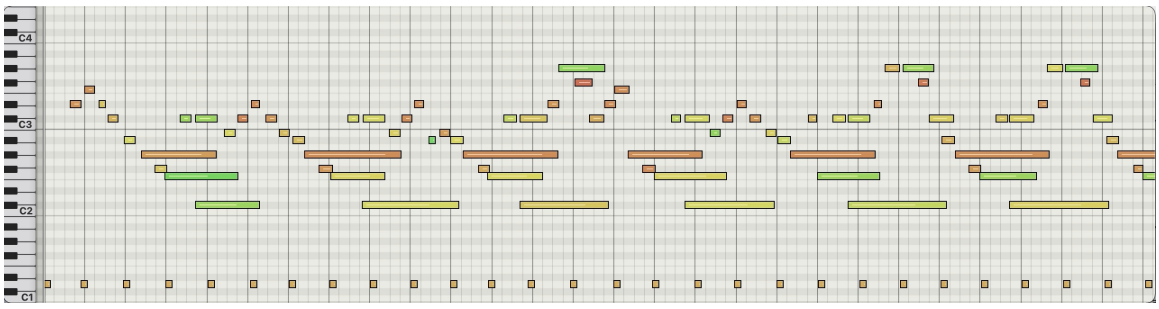

Fig. 1. Transcription of the beginning of "Sojerina" by zither player Velonjoro, with handclaps at the bottom (MIDI file computed by our detection program, piano-roll displayed by Logic Pro, beats indicated on the horizontal axis – note that Logic Pro's binary subdivision of the beat does not correspond to the ternary subdivision of zither playing, MIDI notes on the vertical axis).

The piano-roll reproduced in Figure 1 identifies the first notes in the piece "Sojerina" by Velonjoro, a virtuoso *marovany* player from southern Madagascar, recorded with our sensor-augmented zither in 2014. Since the musician played this piece by listening to a pre-recorded rhythmic sequence with

hand claps and rattle, we know exactly where the pulses fall (represented at the bottom of the piano-roll in Figure 1). Thanks to these pulses, we can attribute the zither part with its correct rhythmic placement. Thus, we were able to collect a large amount of MIDI data from the playing of this musician. For a more in-depth presentation of the methodology associated with this recording / transcription process, see Cazau et al. (2016), Cazau, Chemiller & Adams (2016).

SIMULATION WITH THE IMPROVISATION SOFTWARE "DJAZZ"

At IRCAM and CAMS (EHESS) in Paris, we have also developed a machine learning based improvisation software program called Djazz. Unfortunately, there is currently no general overview of Djazz written in English but such a document will soon be available as we are preparing to distribute this software for free, hopefully in 2023. In the meantime, interested parties might refer to either Lubat et al. (2021) who sets out an aesthetic and historical reflection on the subject or an older presentation of a previous version of the software illustrating the same principles in Nika & Chemillier (2012).

The Djazz software captures whatever a musician plays and then recombines the recorded sequences. Obviously, improvisers do not simply recombine sequences but learning to play patterns that they can reuse when improvising nevertheless represents an important aspect of practice. The software takes into account the beats on which the musician plays, and can also follow the harmonies. When the software makes recombinations, they remain consistent with these parameters despite the lack of any actual musical knowledge, following only a series of clicks and labels for the chords. This lack of musical knowledge means the software is adaptable to any musical style as long as the data applied to train the program belongs to that particular style.

Our improvisation system features two layers, one automatic and one manual. The recombination process coherent with the beats and harmonies takes place automatically. However, users can "perform" with the software, deciding which parts of the memory to apply in recombinations and which effects to add to the algorithm's output, such as looping a pattern, modifying the playback speed or transposing pitches in different registers. The software's degree of autonomy is limited to recombination and holds no long-term view. This aspect has to be handled by the user manually, who thus improvises with the software as a kind of intelligent instrument. In a given cultural framework, the challenge involves obtaining a result that is acceptable to the expert musicians of this culture. Indeed, as we shall see, the software is able to play in the style of a native Malagasy musician.

The software can produce hybrids by mixing various databases captured with several different musicians into its improvisation and thereby exploring many degrees of hybridization. One can thus inject into the Malagasy musical context solos generated within other traditions (for instance jazz) and study how they fit into the musical context according to the native musicians' point of view. We tested this approach with the Malagasy guitarist and singer Charles Kely Zana-Rotsy and his group. In his composition "Save The Earth," the computer injected at 04:11 a passage from a transcription of Brad Melhdau's solo on "The Falcon Will Fly Again" at 01:37 (from the album *Highway Rider*, 2010) represented in Figure 2.

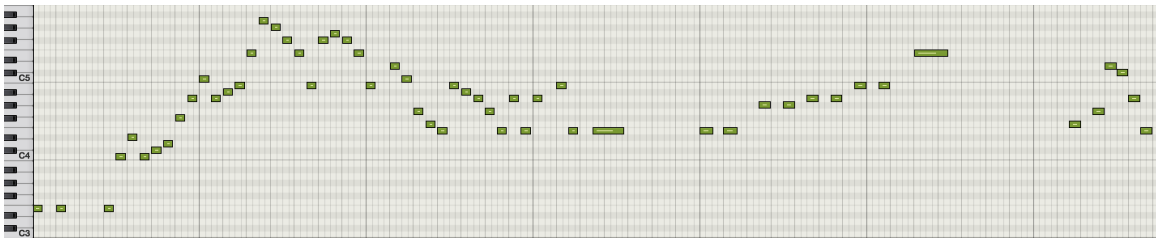

Fig. 2. Transcription of Brad Melhdau's solo on "The Falcon Will Fly Again" at 01:37 reinjected by the computer into Charles Kely Zana-Rotsy's "Save The Earth" at 04:11 (https://www.youtube.com/watch?v=tsTI2M0OBWg). MIDI transcription done by ear, piano-roll displayed by Logic Pro, seven beats per bar indicated on the horizontal axis, MIDI notes on the vertical one.

The software learned from the MIDI data captured by out sensors from the Malagasy zither. When he listened to the first improvisations generated by Djazz based on his own playing in July 2014, Velonjoro's reactions were quite positive. They seemed to mostly relate to the correct rhythmic placement of the motives played by the computer and indeed, the computer was playing with millisecond precision (Chemillier, 2017; Cazau et al., 2016). The full test of acceptability was to be able to duet with the musician, that is, to make the computer bi-musical. The outputs of the program were good enough to allow duets with Velonjoro as took place in May 2016 (https://www.youtube.com/watch?v=xApyhRgMSFU) following a preliminary attempt to duet with this musician in July 2014 (https://www.youtube.com/watch?v=fJXLcTmDnXs). In this perspective, the musician's reactions to the outputs of the machine can shed new light on analysis of his repertoire. Indeed, by refining the generation parameters, we can move closer to an optimal characterization of the music studied.

LIVE DEMO WITH THE GREAT MALAGASY MUSICIAN JUSTIN VALI

Velonjoro passed away on January 10, 2017, at the age of 54, but his data lives on. In 2022, the world-famous Malagasy citharist Justin Vali listened to Velonjoro's data and was inspired to play with him. Resident in France, Justin Vali ranks among the greatest living players of traditional Malagasy music on the zither. He has recorded for the label Real World Records and played in World Music contexts with Peter Gabriel and Kate Bush.

Fig. 3. Portrait of Velonjoro in July 2014 in Mahajanga (photo by Marc Chemillier).

Fig 4. Duet with Justin Vali playing a *valiha* zither and Marc Chemillier playing the Djazz software trained with a database from Velonjoro's *marovany* recordings, Paris, Luna Rossa Studio, February 20, 2023 (photo by Yuri Prado).

We played the database of Velonjoro recordings during the conference-concert at the second Symposium of the SoMoS Study Group in Barcelona on October 26, 2022, in a duet with Justin Vali who performed with the system (http://digitaljazz.fr/2023/06/19/videos-djazz-avec-justin-vali/#sojerina). During the rehearsal sessions before this performance at Universitat Pompeu Fabra, Justin Vali made the following comment on duetting with a computer playing Velonjoro's data:

> I'm going to work hard on this one. For me, it is not obvious [to play at Velonjoro's very fast tempo of 200 BPM], nor for all *valiha* players. Maybe even Vezo players [people from the South-West of Madagascar], for instance Bekamby [a great Vezo zither player], they don't play as fast as Velonjoro. […] Besides, it's my challenge. While I'm not yet completely old, I still want to exploit speed. […] Sometimes, when I'm in there, it goes by itself. But as soon as I start thinking, I completely miss it. [...] When he plays, in the photos it looks like he's laughing, he's like a machine. […] Maybe I need to ask his [Velonjoro's] spirit to help me a little bit with his piece because it's great (Justin Vali, October 16, 2022, see multimedia animation "Madagascar" for a video of this dialogue: http://digitaljazz.fr/multimedia/clesdecoute, Clés d'écoute, 2023)

The use of AI in a World Music context is open to accusations of imposing modern Western biases on this music. Therefore, it makes sense to ask whether Western AI algorithms can simulate musical styles from non-Western cultures. We have already seen that the software makes very few assumptions about the actual music it plays. In addition, Justin Vali's positive reaction showed that he considered the avatar played by the software as fully part of the Malagasy cultural context. In this sense, the computer becomes bi-musical.

There is another interesting idea in Justin Vali's quotation when he invokes the "spirit" of Velonjoro. In trance rituals, the spirit of the dead is believed to speak through the person falling into the trance. More generally in Madagascar, there is "no radical break between the living and the dead" (Decary, 1962, p. 8). David Graeber talks about "the enduring presence of the ancestors" in everyday life (1995, p. 262). This conception of death is interesting to compare with current trends in AI concerning digital life after death. Nowadays, there is a "digital afterlife industry" (for instance Eter9, LifeNaut, Eternime), that produces "goods or services involving the online use of digital data from deceased persons to monetize deaths online" (Nakagawa & Orita, 2022) and we currently understand very little about "the impact of the creation of digital immortals on religious practices and grief management" (Savin-Baden, 2019).

The prospect of applying artificial intelligence to keep the dead alive may be puzzling. However, in a way, classic field recordings made in ethnomusicological approaches to conservation have already done something similar when founding recording archives to preserve a person's memory after death. In the same way, improvisation software maintains a trace of a musician's playing as a type of avatar with the simple difference that the software can imitate as if the musician were playing again postmortem. This raises numerous philosophical, ethical, artistic, and cultural aspects including the due caution and respect for the deceased and their cultural traditions.

CONCLUSION AND FURTHER DEVELOPMENTS

We have here described our analytical research into the repertoire of th Madagascar *marovany* zither. As this instrument is played for very long periods of time during trance rituals, we designed sensors adapted to the instrument in order both to make automatic music transcriptions of its repertoire and to collect MIDI data from the playing of Malagasy musicians. These data are then processed by a computer program designed to improvise and able to play in the style of these musicians. The program outputs are good enough to allow for duets between musicians and the computer. Thus, the scope for such duets involving the use of artificial intelligence may be regarded as an extended form of the notion of bi-musicality introduced by Mantle Hood. Furthermore, we may apply this system for artistic purposes in order to stage concerts with musicians such as Justin Vali, the great zither player from Madagascar. A new version of the software is being designed by Daniel Brown in Max/MSP with a library written in Python. In the artistic context, the role of the computer raises new questions to the fundamental issue of presence in live music, especially when databases of deceased musicians are incorporated, such as that of Velonjoro.

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NOTES

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