Composing and Improvising. In Real Time.

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Abstract. This paper presents a summary of my keynote address discussing the differences between real-time composition (RTC) and improvisation. A definition of real-time composition is presented, as well as a summary discussion of its theoretical framework. Finally, a comparison between RTC and improvisation is done taking into account Richard Ashley's discussion of improvisation from a psychological perspective [1], which provides an interesting insight in this distinction. RTC is then redefined as *improvised composition with computers*, and the possibilities of RTC existing outside of computer music are also briefly addressed.

Keywords: Composition, Improvisation, Real-Time Composition

1 Introduction

I define real-time composition (RTC) as a "*Compositional practice* utilizing *interactive* music systems in which *generative* algorithms with a *non-deterministic* behavior are manipulated by a user during *performance*" [14]. The terms in italic also define important keywords about RTC: it is a performative practice, it is interactive, it is generative, and non-deterministic. In a recent paper [16] I provide a more detailed contextualization and framework of RTC in the context of my work. This short paper summarizes my recent keynote at the 13th Symposium on Computer Music Multidisciplinary Research where I addressed the differences between RTC and Improvisation.

RTC is a practice made possible by computers and has become increasingly present in music making. This is due to the progressive shift from using the computer as a machine that can provide sonic results otherwise unachievable by other means, towards the increasing use of the computer as some sort of musical companion with a musical behavior of its own in interaction with its users. Twenty years ago, the use of the computer as an interacting entity in musical performance could only be appreciated in specialized computer music concerts in certain (restricted) environments like universities or conferences. Nowadays it is not uncommon to carry an application on your smartphone that produces music interactively through tapping or swiping gestures on the phone's touchscreen.

This paper is comprised of four sections. This introduction, a brief section on the definition of RTC systems, their taxonomy, and anatomy; a section in which I discuss

a theoretical framework for RTC; and finally, a section where the fundamental differences between RTC and Improvisation are analyzed and explained.

2 RTC Systems: Definition, Taxonomy, and Anatomy

Real-time composition systems are interactive music systems [22] that enable composition in real time. These systems exist in the form of standalone applications, plug-ins, or even as libraries or programming environments that facilitate their creation. They can operate at the sub-symbolic or symbolic levels. The majority of existing RTC systems operate at the symbolic level.

Two levels of utilization of these systems can be identified: systems designed for common/lay users and systems for specialists.

Systems for common/lay users are easy and simple to operate and the processes inherent to music/sound generation are hidden from the users — e.g. *Bloom* [12].

Systems for specialists require specific knowledge for their operation. These can be programming environments, specialized libraries or even commercial software designed to be operated by users who have acquired specific knowledge for their operation — e.g. Karlheinz Essl's RTC Lib,[1] Max,[2] or Supercollider.[3]

A RTC system should possess at least two components: a musical search space that is defined by a generative algorithm, which provides the musical material that can be obtained and transformed by navigating that space, and parameter controls that provide access to that space or its features.

The work I have been involved with in the creation of RTC systems both for lay and specialized users [13, 25, 7, 15], follows the framework just described.

3 Discussion of a Theoretical Framework for RTC

The revolution computers operated on musical practices have created substantial breaches with the concepts and definitions of the pre-electronic/computer music practice. Notions of what constitutes a musical instrument, what is performing, composing, and improvising, have been shaken to a point that new definitions, re-definitions, and taxonomies are emerging to address these basic notions. Departing from an initial intimate relation to traditional music concepts to describe computer music constructs such as "score," "orchestra," "instrument," "player;" using interaction metaphors such as "soloist with accompaniment," "conductor with orchestra," "Jazz combo," the field of computer music has expanded in ways that originated different avenues of musical expression as well as new concepts. One of them is real-time composition.

Essentially, an RTC system is a peculiar combination between digital musical instrument design, algorithmic composition approaches, and interactive music systems.

[1] http://www.essl.at/works/rtc.html

[2] http://www.cycling74.com

[3] http://supercollider.github.io

Digital musical instruments enable the creation of complex mediation spaces between physical gesture and sonic result. Generative algorithms occupy these spaces to mediate the interaction [6]. Interactive music systems provide the possibility of modifying the behavior of these algorithms in real time and enable a metalevel approach to composition through the possibility of interactive and real-time control of the musical generation [22, 23].

3.1 On Digital Musical Instruments

The notion of what is a musical instrument and what types of class of instrument are there has been dramatically challenged with the advent of electronic and computer-based instruments (cf. [18]). On one side, there is the question if a musical instrument can (still) be considered a single sound-producing body as nowadays — especially with the use of distributed sensing, processing, computational and streaming technologies — this may not be always the case. On the other side, the emergence of what Joel Chadabe [6] has termed interactive instruments, or indeterministic electronic instruments, blurs the notion of what a musical instrument performance is in the traditional sense. In a recently-published paper [21], Thor Magnusson proposes a taxonomic approach, which he calls "Musical Organics," to the analysis and classification of both traditional and new musical instruments that, according to him, "suits the rhizomatic nature of their material design and technical origins" (p. 286). In an earlier paper [20] He advances the idea that many digital instruments could be seen as extensions of the mind rather than of the body (as in the case of traditional instruments). This is precisely because of the possibility they afford of using computational music systems to build expressive intelligent sonic outputs.
In his comparison between acoustic and digital instruments [20], Magnusson states that the "primary body of the digital instrument is that of symbolic instructions written for the meta-machine, the computer. As opposed to the body of the acoustic instrument, the digital instrument does not resonate." (p. 168) The use of computational techniques such as generative algorithms "and their theoretical implications unavoidably involve an explicit systemic representation of music as a rule-based field or a creative search space" ([3] qtd. In [20], p. 169).

3.2 On Algorithmic Composition

Perhaps the most important characteristic that frames RTC within the realm of musical composition is the use of algorithms which provide creative search spaces to be explored interactively. Charles Dodgde and Thomas Jerse [8] acknowledged two broad categories in which algorithmic composition with computers fall into: stochastic music, in which events are generated based on some statistical representation; and music in which the computer is used to calculate permutations of predetermined conditions. In both situations the computer is providing musical, navigable spaces that bear the characteristics defined by, and implemented in the algorithm.
This navigable space is typical of algorithmic composition with computers, and was identified by Iannis Xenakis [28] on his famous account of his first experience with the

computer in 1962. The control/alteration of parameters in algorithmic computer music provides the possibilities for navigation of a musical space whose limits are defined by the ranges of values in the parameters.
Heinrich Taube [26] considers the metalevel as a representation of the composition of the composition in algorithmic music: "A metalevel representation of music is concerned with representing the activity, or process, of musical composition as opposed to its artifact or score" (p. 3). He makes a pertinent distinction between computer-assisted, automatic, and computer-based composition as three different possible ways to engage with algorithmic composition. In short, he considers computer-assisted composition a situation where the computer facilitates compositional tasks such as computing pre-compositional data, and as a simulation tool; automatic composition relates to systems that compose music independently (e.g. David Cope's EMI). Finally, computer-based composition,

> [M]eans to use the computer to explicitly represent compositional ideas at a level higher than the performance score. An explicit metalevel representation means that the relationships and processes that constitute a composition (the composition of the composition) are represented inside the machine apart from the composer thinking about them. (p. 5)

Taube does not consider the temporal scale at which computer-based music can occur. Although he may not even be considering the real-time application of these concepts the properties of computer-based music he mentions can certainly be found in RTC systems.

3.3 On Interactive Music Systems

Interactive music systems constitute a possible way of designing the contact between gestural interfaces and compositional algorithms in digital musical instruments. Chadabe [6] calls these type of instrument "interactive instruments." Jon Drummond [9] rightly and succinctly asserts that "[i]nteractive systems blur these traditional distinctions between composing, instrument building, systems design and performance." (p. 124). The complexities of relations that can be established with interactive music systems challenge the traditional paradigms in music performance, composition, and instrument design.
Brown, Eldridge and McCormack [4] criticize the acoustic paradigm often used as a metaphor to describe the types of relationship that can be established between the users and these systems (see for example [22, 27]), and suggest new paradigms for addressing the new interconnections that can be established between software systems in these new situations.
The reality is that interactive music systems contribute to blur these distinctions, which are often imperceptible when one watches a performance. The performers of a certain system may even not grasp what the system is doing while they're performing it such as in the case of certain games or applications. This makes it hard to really understand where does one establish the boundary between digital instruments that simulate

traditional instruments and RTC systems, or other interactive instruments that are not RTC systems. Moreover, if whatever one is doing while interacting with the system should be considered performing, improvising, or composing.

4 Improvisation vs. Composition, Composing with Improvisation, and Improvising Composition

The practice of improvisation is certainly as old as music itself. The interaction between improvisation and composition — especially with the advent and evolution of jazz and the emergence of other types of improvised instrumental music in the second half of the 20th century in the West — has created tensions that entail quality judgements about "composed" vs. "improvised" music: "composed" music generally tends to be taken "more seriously" than "improvised" music.

Yet, paradoxically, as pointed out by Vijay Iyer [17] one "recurrent conceit among classical musicians, critics and listeners is that the best performances of composed works are those that 'sound improvised'"(p. 172). Even though the performer is executing with utter precision the indications given by the composer, the "improvisatory character" denotes a fluency in performance that is commonly appreciated. Conversely, and not uncommonly, one of the praised qualities of "good" improvised music is that it sounds like written, "composed" music [17, 24].

Iyer [17] notes that it is hard to aurally identify the "improvised" passages in music. It is perhaps easier to identify those that sound "composed." Sequential motivic manipulations or points of synchronicity between musicians actually may lead the listener to infer that there is some sort of script supporting the music being performed.

In the world of music that combines improvisation with written/scripted sections it is even harder to distinguish where "composed" and "improvised" sections begin and end. But then, why make (and insist) on this distinction as a quality judgement?

Iyer notes that this brings us to a central paradox: "the drama of improvised music involves the understanding that those sounds were chosen and deployed at that moment by those people. And yet, you cannot tell this to be true just by listening: you have to already know that this is happening. It follows that you only really know by referring to something beyond the sound." (p. 174).

Being a musician who had an education both in the "classical" European tradition and in Jazz, who increasingly introduced improvised sections in his music, and who has never done any special value distinction between music from improvised traditions or music from the European erudite tradition, I feel a strong empathy with Iyer's views. For me, it is more important to understand the different ways in which improvisation can work in music, interact with composed/scripted sections, as well as the ways in which can be articulated.

In the case of computer music, what is the relationship between Real Time Composition and improvisation?; or how can the approach proposed by my definition be ported to improvised instrumental performance?

The tension surrounding the composition-improvisation dialectic has permeated into the computer music world too. Arne Eigenfeldt [10,11] and George Lewis [19] are two

authors who have largely discussed the distinctions between RTC and improvisation, and the ontology of RTC itself. I take a slightly different approach that resonates more with Chadabe [5] by acknowledging RTC as an inherently improvisatory practice that is fundamentally different from improvisation with musical instruments. Real-time composition allows *improvising while composing*. This is something fairly new in the musical landscape and only possible because of this particular combination between interactive music systems and generative algorithmic composition in the context of digital musical instrument design. What are then the fundamental differences between improvising while performing an instrument and improvising while composing?

In his analysis of Improvisation from a psychological perspective, Richard Ashley [1], provides interesting insights that may help distinguish the differences between improvisation with musical instruments and improvisation with compositional algorithms. He distinguishes three constraints that operate on the processes of musical (instrumental) improvisation: 1) The body; 2) Real time; and 3) Limits on what we know.

In instrumental performance, the musicians work with their hands, feet and voices to produce the music. The physical capabilities of the body, and the training the body has obtained impose limits on what can be produced musically during the improvisation. The real-time aspect also constitutes an important constraint as there is a complex process of decision-making going on for determining what gets played, and how, as well as its consequences on establishing the musical narrative on the immediate future. Finally, perhaps the most important constraint in this characterization, is the limit of what the performer knows while improvising (cf. [2]). Ashley asserts that in the case of improvisation, the knowledge one uses is/should be encoded in procedural (know-how-to) form rather than in declarative (know about) form.

The perspective presented above is perhaps the one that so far provides a potential distinction between instrumental improvisation and RTC. When one is composing in real time, constraints 1 and 3, respectively the limits of the body and of what we know are substantially extended, if not abolished:

- One is operating an algorithm (or set of algorithms) that can produce musical results that go beyond the limitations of the body.
- One can rely more on declarative knowledge for the musical generation — i.e. know about the effects certain algorithms produce rather than having to know how to produce them — and perform with algorithms that can provide unexpected results.

Based on the above assertions, one could revisit the above definition and redefine real-time composition simply as *improvised composition with computers*.

4.1 Can RTC Exist Outside of Computer Music?

The short answer is yes, of course. One can work with a group of musicians as if they were “generative algorithms” and try to “manipulate” their content generation by interacting with them through specific instructions. (e.g. in the case of Soundpainting).

However, this situation is substantially different from the traditional improvisation that occurs in Jazz, which is sometimes also called "real-time composition." For RTC to exist as a practice of improvisation with composition, some sort of metalevel needs to be established.

The piece I composed for this conference, "On the resolution of regional tensions," for big band and live electronics, a commission from Orquestra Jazz de Matosinhos explores the nuances and tensions between real-time composition, non-real-time composition, and improvisation. This piece has sections that are composed in real time by the conductor, who gives instructions and interacts with the musicians as if they were generative algorithms with a certain musical behavior (Fig. 1). These sections are oriented towards other sections that are fully notated, and in which the musicians may improvise in ways that are more traditional in Jazz performance (Fig. 2). In these latter sections, no matter how much the musicians try to move away from the music being executed, there is a structure that creates an unavoidable referential pole around which the music being performed orbits. In the sections that are composed in real time, this structure is fluid and built as time passes even though there are specific points in the music (the notated sections) to be reached.

Fig. 1. Detail of a section of real-time composition in the score of "On the resolution of region tensions" with algorithmic-like indications to musicians and to the conductor.

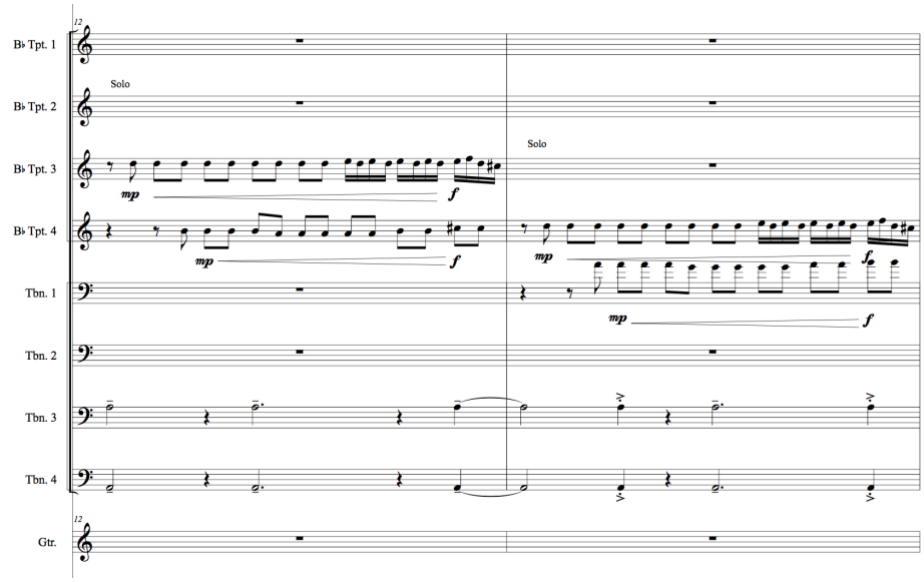

Fig. 2. Detail of a section combining improvised and notated music on "The resolution of regional tensions."

This piece tries to highlight yet another qualitative difference between RTC and improvisation. In improvisation, there is a referential point (harmonic structure, vamps, texture, other referential elements that bind the musical discourse) around which the music moves. Improvisation could then be seen as a concentric structure. RTC could be seen as a swarm structure that moves fluidly as a consequence of the interaction between the different elements that is controlled externally by another entity.

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