Ripples: A human-machine musical duet

Andrew R. Brown
Griffith University, Brisbane, Australia.
andrew.r.brown@griffith.edu.au

Abstract

Ripples is a human-machine musical duet where the human performance stimulates a cascade of responses from generative music software. The work emphasizes chordal and arpeggiated material derived, in the machine's case, from underlying patterns of oscillation. The Ripples software listens to MIDI input from the musician's performance and responds in real-time with generated MIDI output. It is designed for live performance by two instruments but may be adapted for other configurations. The musician is expected to play in a style influenced by, and sympathetic to, the character of the generative output. The structure and duration the performance is at the discretion of the musician. The behavior of the generative software is fixed, but does adapt by 'listening' to the musician's performance. This article details the algorithmic processes of the generative system, the types of interactions and adaptations employed, and provides descriptions and examples of some contrasting performances of the work. The design of Ripples demonstrates how a relatively simple generative process, coupled with nuanced interactive elements, can give rise to a musical metacreation system (a compositional design) that is aesthetically effective in improvised duet performances with a sympathetic human musician.

Introduction

Ripples is an interactive music composition that includes a generative software system designed to be a musical duet partner with a live musician. Ripples' algorithms operate on symbolic data by accepting and outputting MIDI messages; therefore the sonic characteristics of a Ripples performance can vary at the performer's discretion and depend on the instruments used. To date, performances have been done with MIDI controlled acoustic pianos and with a MIDI keyboard and software synthesizers. The work gains its distinct characteristics from a generative engine utilizing several layers of arpeggiated patterns. However, each performance can vary significantly depending upon instrument choices, the musician's performance style, and their choices about directing the structure and form.

The computational processes employed by Ripples are a combination of generation and transformation (Boden 2010:33). The agent-system acts a creative partner during performance by listening and analyzing the human performance and conditioning its own generated response as a result. During the process there is significant transformation of its generated material and, arguably, distant transformation of the human material. More convincingly, the Ripples software can be described as a creativity support tool and the Ripples compositional design as a metacreative system.

Generative Processes

The basis of Ripples generative process is a monophonic arpeggiation pattern whose direction is influenced by a low frequency sine oscillator. This algorithm uses a combination of a random walk and sample-and-hold operations. Each pitch in the arpeggiated pattern is based on an intervallic step from the previous pitch—like random walk—and the intervallic direction is based on the current magnitude of the LFO—positive, negative, or zero. Resulting pitch values are quantized to a dynamically variable scale (pitch class set) to maintain harmonic integrity within the work. To avoid the otherwise inevitable periodic melodic curve, the intervallic steps of the arpeggiation pattern are changed quite regularly (every beat) thus mixing up the regular sequence into more interesting intervallic groupings. Variation can also be applied by varying the LFO rate. The natural rise and fall of the LFO amplitude serves to provide, to some extent, an inbuilt range constraint, but range boundaries need to be set for both practical (MIDI pitch range) and aesthetic (voicing distribution) reasons.

Rhythmic organization is based on simple integer beat subdivisions of 1, 2, 3, 4, 6, and 8. This provides pulse stability through consisted beat regularity whilst probabilistically varying subdivisions for each beat to provide vari-

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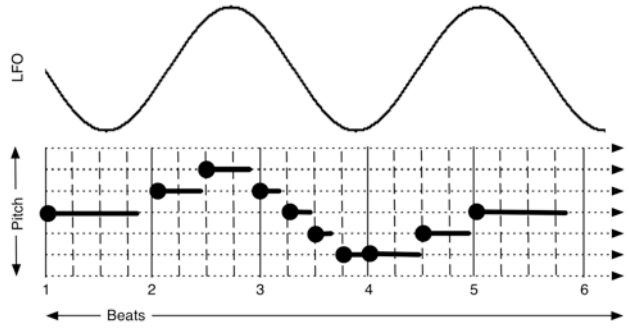
ety. These pitch and time quantizing processes result in a monophonic line mapped to interval-duration matrix driven by the underlying periodic motion as shown in figure 1.

In Ripples, three such parts (agents) are generated to provide a polyphonic texture. In some cases each agent is applied to the same timbre, as with the MIDI controlled acoustic piano performances. In this case the generated part appears more like a single computational 'pianist' than as independent parts—thus invoking a sense of a duet performance. In other arrangements the agents are assigned to individual synthesizer timbres making their independence more obvious—sounding more like a small ensemble.



Future 1. Example note output on a pitch-beat grid when interval is fixed to a value of 1.

Interactivity

While the generative process could run independently, a key element to Ripples is the way in which it moves beyond generation to embrace interaction with the intention of forming a cybernetic system with the musician. To accomplish this Ripples relies on a combination of reflexivity (Pachet 2006) and reactivity (Bongers 2000). The objective is to provide a balance of independence and collaboration—as perceived by the performer and audience. Overall the Ripples design adopts a somewhat minimal approach to computational creativity relying quite heavily on rule-based generative functions and the musician's improvisatory skills to guide the performance.

The reflexive aspects of interaction are limited to harmonic and dynamic elements. The software maintains a short history of the pitch classes and velocities played by the musician. It uses these to condition its output. The generated material limits its pitch selection to this pitch class history with the effect that the software follows the harmonic language of the musician. The generative algorithm has some expressive dynamic properties but they are moderated by the running average of the recent dynamic history of the musician's performance, with the effect that the software agents tend to mirror the musician's dynamics. Finally, rhythmic subdivision choices are moderated by the musician's velocity history such that louder dynamics lead to higher value subdivisions, thus coordinating loudness and rapidity, acting as a kind of 'intensity' variant.

The reactive aspects are managed by having the agent's playback limited to short fragments that are triggered by the musician's performance. This simply means that when the music plays or stops, so does the generated output. This can be considered a micro-level call and response, but the overlapping nature and metric independence of the agents means that the effect is more of a polyphonic lattice than a distinct call and response; especially when driven by continual performance input.

Performances

At the time of writing, Ripples has been performed several times during 2015 and 2016. In this section two contrasting versions will be discussed. One performance by jazz pianist Sean Foran used two Disklavier pianos, one for him and the second for the Ripple's software output. This setup visually reinforces the duet intention with each instrument providing both visual and sound source separation. An image from the performance shown in Figure 2 and a link to a video of the performance can be found here: https://youtu.be/9AxslQWZ4-U

Figure 2. Sean Foran performing Ripples at the Queensland Conservatorium, 11 September 2015.

For this performance an additional interactive parameter was added so that sustain pedal actions of the performer were mirrored on the second piano. The performed part was improvised, based on experience during several rehearsals in the weeks prior to the performance.

A somewhat contrasting performance was done by the author at the Australasian Computer Music Conference 2015 in Sydney. This interpretation saw the performer playing a MIDI keyboard and laptop, as shown in Figure 3, that hosted several virtual synthesizers, one for the musician and one for each of three software agents.

The independent instruments for each of the generated agents allowed the performer, in this version, to vary the balance between parts during performance thus varying the

orchestration over time. A video of the performance can be found here: https://youtu.be/fTqtYqyPZyk

Figure 3. Andrew R. Brown performing Ripples at the Bon Marche Studios, 19 November 2015.

Conclusion

The Ripples composition is a musical metacreative design for a multi-agent system that acts as an improvising duet partner. Ripples is characterized as a 'composition' because the generative processes have a distinct character defined by the developer (composer). The software employs elements of reflexivity and reactivity that assist in its ability to behave in a musically sympathetic fashion but the success of a performance of Ripples relies on similar, if not greater, sympathetic musicianship from the human performer. The algorithmic processes involved employ probabilistic and oscillatory techniques previously discussed by the author as useful for a succinct description of artificial musical behavior (Sorensen and Brown 2007; Brown, Gifford and Davisdon 2015). The reactive interactive techniques employed in Ripples, draws on elements of dialogic reflexive systems (Pachet 2002) and rule-based pattern behaviors (Kay 2004). The system has been trailed successfully is public concert performances; links to some examples of these are provided in this article. Ripples software is implemented in Extempore (Sorensen 2010) and is publicly available for download and performance via GitHub at: https://github.com/algomusic/Ripples-composition.

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