Instrument design using machine learning and artificial intelligence

Bernt Isak Wærstad[1]

[1] Norwegian Academy of Music, Oslo, Norway
bernt.i.waerstad@nmh.no

Abstract

Immediate haptic response and resistance, both physically and musically, are properties I often find lacking in digital musical instruments. These properties are important creative catalysers greatly affecting both the expressive capacity and the interaction between the instrument and the performer. This project will search for new and possibly more idiomatic modes of response and resistance for digital musical instruments. I will develop new strategies for instrument design based on machine learning and artificial intelligence and use these strategies to both expand my existing instruments and design new responsive and autonomous instruments.

Keywords: Instrument design, Machine Learning, Artificial Intelligence, Computational Creativity

1. Purpose of the research and its importance to the field

While there have been several efforts to mimic haptic responses and resistances similar to those found in acoustic instruments using sensors, motorised controllers, transducers etc, that is not the goal for this project. Instead of trying to copy physical properties of acoustic instruments, I want to focus on exploring instrumental designs that are only possible with digital technology and research modes of instrumental response and resistance that are more idiomatic to the digital domain. By using techniques from machine learning and artificial intelligence in combination with generative techniques and algorithms from the field of computational creativity, Im planning to explore and develop new personal strategies for digital instrument design based on my own artistic expression. These strategies will be both used to expand my existing instruments and to design new responsive and autonomous instruments.

As of now, I see two main areas in which I imagine machine learning and AI can be put to interesting artistic use for the purpose of responsiveness and autonomy. The first area is related to adaptive forms of processing using different analysis techniques from the field of Music Information Retrieval. I obtained a lot of valuable experience in this field as a participant in the research project “Cross adaptive processing as musical intervention”[1] which led to new insights in working methods in designing and using adaptive instrument (Brandtsegg, Engum and Wærstad 2018). This project will continue the exploration started in the cross adaptive project by exploring these different MIR techniques can be combined with supervised machine learning algorithms, though in a mostly in a more pure adaptive fashion (not cross). I’ve started this exploration by expanding and enhancing my existing digital musical instruments (see performance submission for ICLI 2020 named “Ghost Doctor Duplicate”).

The second area is more related to idea of autonomy and artificial intelligence. Or perhaps artificial artistic identity would be a better term. The idea of having instruments with a certain form of “personality” which can develop and evolve over time is fascinating in it self and provokes a lot of questions and reflections around art making in it self when you as an artist give up some level of control and leave room for an artificial artistic voice. But I find it perhaps even more interesting how performing with this instruments affects me as a performer over time. This also relates to how we

[1] http://crossadaptive.hf.ntnu.no/index.php/about-the-project/

perceive the machine and its output, having a sense of agency and interpret actions as musical intent. In my early experiments, I found that even a simple smooth random walk produced a lot of, to me, meaningful musical ideas and initiatives. So introducing any kind of agency, even a random impulse, into the instruments are already giving me some sensation of autonomy from the machine, which directly affected my playing and encouraged a musical responses (a short excerpt can be heard at [2]. This project will explore generative and algorithmic processes like Markov Chains, Lindenmayer Systems, Cellular Automata and GANs combined with different MIR techniques and reinforcement learning to develop a performance AI. In the long run, my goal is to develop an autonomous system with its own artistic identity, which can evolve over time in symbiosis with me as a performer.

2. Background and related work

The idea of having autonomous music producing machines are by no means new and this project are based on ideas from early algorithmic music systems like "Voyager" by George Lewis from 1993 (Lewis 1999) and "Improsculpt by Øyvind Brandtsegg (Brandtsegg 2001). More recent examples are the machine improvisation system "PyOracle" (Surges and Dubnov 2013) by Greg Surges and Shlomo Dubnov and the AI performance system named "Tomomibot"[3] by Andreas Dzialocha, Tomomi Adachi and Marcello Lussana.

Other relevant and related work includes the Fluid Corpus Manipulation project (FluCoMA), which are researching new ways of doing segmentation and classification of sounds and building different corpuses (Roma, Green and Tremblay 2019) and the MuBu toolbox for Max/MSP from Ircam which includes tools for interactive machine learning, audio analysis, gesture recognition and more[4]. Also related is Charles Martin, a loose collaborator on this project, who is researching how to do creative predictions using recurrent neural network and has developed an interactive musical prediction system (Martin and Torresen 2019). Other important tools include Rebecca Fiebrink's "Wekinator"[5] and Sam Parke Wolfe's encapsulation of the Rapid library as an Max MSP external, "RapidMax"[6].

3. Proposed approach

The exploration of the mentioned techniques and tools will lead to the development of new tools, design of new digital musical instruments and extension and enhancements of existing instruments. These instruments will be used both as part of my solo performance practice and in interplay with other musicians and artists. The nature of this process is cycling rather than linear, where musical performance produces artistic reflection which forms the basis of the continued technical development leading to an improved instrument with which another musical performance can take place. In this way, both instrument and me as a performer will evolve and develop new skills and features together. It's also important that different modes of musical performance (rehearsal, concert, studio recording) are carried out to have varied foundation for reflection. Discussion and reflection with collaborators, colleagues and audiences will also be an important part of bringing this project forward.

---

[2] https://soundcloud.com/mrbernts/a-smooth-random-walk

[3] https://github.com/adzialocha/tomomibot

[4] http://ismm.ircam.fr/mubu/

[5] http://www.wekinator.org

[6] https://github.com/samparkewolfe/RapidMax

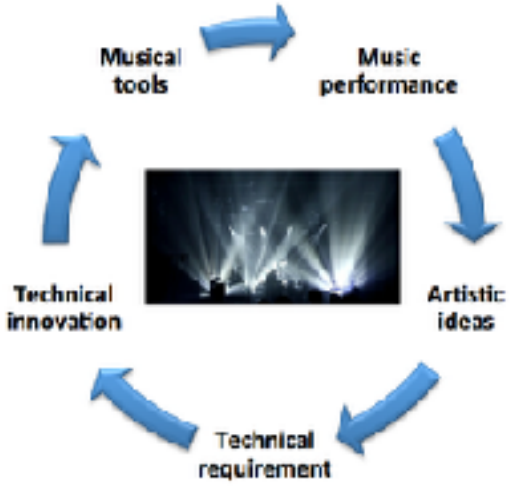

Figure 1. The cyclic instrument design process

4. Expected contributions

As this is an artistic research project, the main focus for the project is my own artistic expression and performance practise, but there are also some outcome that will be beneficial to the field in various ways. I'm collaborating with my colleague Notto Thelle, Phd student at the Norwegian Academy of Music, who is working on a project titled "Mixed-initiative composition: Mapping human agency for Machine Learning". We're developing a flexible machine learning system which can fit both our needs, since we've found that we have a lot of technical overlap even though he is focusing on composition and I am focusing on performance. Both our tools and reflections will also contribute to another project at the Academy: "Goodbye Intuition"[7] with Ivar Grydeland, Andrea Neumann, Morten Qvenild, Sidsel Endresen and Thom Johansen (NOTAM).

5. Progress towards goals

Having just started up a few months ago, the project is still very much in its infancy with the contributions to this conference being the first public outcome. The project is formally of limited reach so far being tied to a 20% research position for one year, though applications have been made for further funding. I plan on developing this project further with the goal of having it evolve into a more comprehensive artistic research project which would serve as the foundation for an artistic phd.

The next step for this project is a weeklong workshop in Vancouver at UBC, where I will collaborate with Bob Pritchard, Kiran Bhumber and Seshen. This workshop is based around an improvisation duo with Seshen (vocals) and me (electronics) where I do live processing and looping of Seshen's voice, and Bob and Kiran's bespoke touch sensor suits (Bhumber, Pritchard, Rode 2017) combined with motion tracking cameras. I will explore machine learning techniques to both extend my existing instrument with adaptive responses from Seshen's voice and movement and also work on a new AI performance instrument based on Seshen's sensory control and a library of prerecorded voice sounds. The resulting performance will be show in both Vancouver and Oslo.

After Vancouver, the main milestones in the project before the current ending date on 31st of July 2020, will be participation at this (ICLI 2020) conference, a series of studio recordings in April which eventually would lead up to an album, a solo concert in late spring and participation at the NIME 2020 conference in Birmingham if accepted.

---

7 https://www.researchcatalogue.net/view/411228/424771

References

Bhumber, K., Pritchard, B., and Rodé, K., 2017, "A Responsive User Body Suit (RUBS)", *Proceedings of the International Conference on New Interfaces for Musical Expression*, Aalborg University Copenhagen, pp. 416–419

Brandtsegg, Ø., Engum T., and Wærstad, B. I., 2018, "Working methods and instrument design for cross-adaptive sessions." *Proceedings of the International Conference on New Interfaces for Musical Expression, Virginia Tech,* pp. 1–6

Brandtsegg, Ø., 2001, *Retrieved November 12, 2019, from http://oeyvind.teks.no/results/Reflection process.htm*.

Lewis, G., 1999, "Interacting with latter-day musical automata", *Contemporary Music Review, 18:3*, 99-112

Martin, C. P. and Torresen, J., 2019, "An Interactive Musical Prediction System with Mixture Density Recurrent Neural Networks", *Proceedings of the International Conference on New Interfaces for Musical Expression*, UFRGS, pp. 260–265

Roma, G., Green, O., and Tremblay, P. A., 2019, "Adaptive Mapping of Sound Collections for Data-driven Musical Interfaces", *Proceedings of the International Conference on New Interfaces for Musical Expression*, UFRGS, pp. 313–318

Surges, Greg & Dubnov, Shlomo., 2013, "Feature Selection and Composition using PyOracle". *AAAI Workshop - Technical Report*.