Loop Fracture Loop

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1 Program Notes

An free improvisation between players of two augmented instruments, both with *tunable machine learning*. Accorsi plays an augmented saxophone, whose sound is processed through effects that are controlled by an audio-reactive machine learning system. The same system is used by Kiefer in the feedback loop of their string instrument, the Xiasri. Both instruments use a novel reinforcement learning system, NISPS, that the player trains through performative exploration and expression of musical preferences, with the interface built into the instrument.

2 Project Description

Loop Fracture Loop is the most recent in a series of performances in the co-research collaboration between Accorsi and Kiefer. Accorsi is a professional musician, and one of the long-term collaborators on the Musically Embodied Machine Learning (MEML) project, led by Kiefer.

The MEML project has been running for two years, exploring the creative potential of *tuneable* machine learning (ML) when embedded and embodied within instruments. *Tuneable ML* means that the instrument offers interfaces and workflows to train the machine learning processes that are embedded within; the project is motivated to explore how ML interfaces can become a fundamental part of an instrument, moving away from data science environments and static inference-only models towards dynamic and musically malleable ML. *Tunable ML*, when embedded in musical instruments, has the potential to offer new creative opportunities, by enabling complex processes to exist within an instrument that might be customisable through simple or intuitive embodied interactions.

During the project, the authors have been co-designing instruments that explore these themes. Accorsi's instrument is an augmented saxophone, and Kiefer plays a feedback string instrument.

Both instruments use the same core-technology, the MEMLNaut. The MEMLNaut is an experimental platform for research into tunable machine learning. It is designed to enable exploration into how small data [1] and interactive machine learning approaches [2, 5] can be integrated into musical instruments. It is a small hardware unit, offering a low-power microcontrollers, a small touch screen, audio and MIDI, a set of hardware controls, and breakout pins for customised expansions with sensors and inter-device communications. As such, it can be customised in a range of musical scenarios, to augment instruments with ML capability, or to be used itself as an instrument. For example, during the project, we've built an augmented euphonium, guitar effect units, gestural controlled vocal processors, generative rhythm for modular synthesis, digital synthesis, creative studio production tools, multi effects units and livecodeable control voltage generators. The project is open-source; hardware files and code are available on Github[1].

The most recent MEMLNaut firmware, which we will use in the performance, implements a system called NISPS (Neural Interactive Shaping of Parameter Spaces). NISPS is a system for designing complex many-to-many mappings with neural networks. It offers a form of Reinforcement Learning (RL) [4], where the musician adjusts mappings through performative exploration and expression of musical preferences. It also affords ways to intervene directly in the RL training process. Figure 1 shows an overview of the NISPS workflow. This system is part of a small but growing body of research into RL in NIME e.g. [3, 6, 7].

[1] https://github.com/MusicallyEmbodiedML

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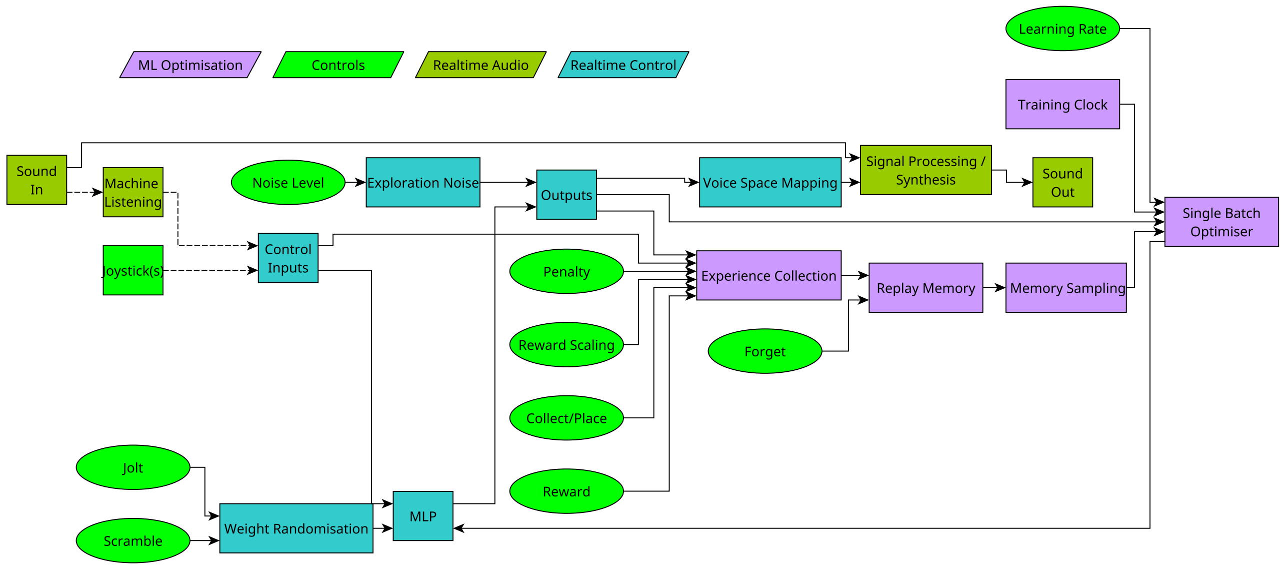

Fig. 1. Workflow in the NISPS system

2.1 Instrument 1: Augmented Saxophone

Accorsi's instrument is a tenor saxophone, augmented with two dual exciters. A microphone mounted on the bell sends audio via a preamplifier into the MEMLNaut. The MEMLNaut analyses the sound with a set of machine listening algorithms, creating 6 inputs to a neural network, which projects these inputs to a higher dimensional space of outputs. The outputs control the parameters of a set of effects which process the signal from the saxophone, and outputs of which are played through the exciters into the saxophone body. The effects are a combination of pitchshifting, delay lines, comb filters and allpass filters, with 24 control parameters. The instrument is set up so that feedback and self-resonation are avoided, but the effected sound, projected into the body, couples with the acoustic sound produced by the player. The effects, driven by machine listening analysis, morph and shift according to the sound of the instrument. Before the performance, NISPS is used to configure the neural network, and therefore shape how the effects react dynamically with different sounds from the saxophone. NISPS is controlled with buttons on a MIDI footpedal, to give positive and negative feedback, to scramble the neural network and reset the experience replay memory.

2.2 Instrument 2: Xiasri

Xiasri (a feed-backronym for 'Xiasri Is a Self-Resonating Instrument') is a custom made feedback string instrument. It has two bass guitar strings mounted on a bamboo body, with two custom-made pickups, feeding their signals into four dual exciters mounted at the base of the body. The MEMLNaut sits within this feedback loop, running a similar firmware to the saxophone, except with the intention of creating feedback and self-resonation. The player can bow the instrument, and can shape feedback through damping the two strings. A footpedal modulates the overall gain of the system. For the Xiasri, NISPS helps to performatively design and adjust the mappings, which can be a challenging task with other approaches The dynamic approach enables the mappings to be shaped in the moment of playing, as opposed to a less intuitive cycle of offline modification and evaluation.

2.3 Performance History

The authors have previously played together on two occasions, exploring this technology as it has evolved, at Mengi in Reykjavik, Iceland, and at The Rose Hill in Brighton, UK.

3 Technical Notes

We will need:

- Two stools or chairs without arms.
- Two microphones and stands, one for each instrument
- Two DI boxes, to capture the output of each MEMLNaut unit (to be mixed with the microphone sound)

- On-stage monitoring
- Two power sockets

4 Media Links

- Video: https://youtu.be/Q63vylNbmIU
- Audio: https://www.bettyaccorsi.com/
- Audio: https://luuma.net/

5 Ethical Standards

This project has received ethics approval from the University of Sussex Social Sciences and Arts Research Ethics Committee. All participants have given informed consent.

Acknowledgments

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