Commingling Artificial Life and Interactive Machine Learning in Diffractive Artistic Research Practice

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Abstract

As research and artistic practices increasingly combine diverse techniques from across artificial intelligence, the integration of artificial life (ALife) and interactive machine learning (IML) represents an underexplored yet promising area. While seemingly disparate, both approaches have been popular with artists due to their potential for lightweight, real-time interaction with complex behaviours. This paper investigates the hybridisation of ALife and IML through diffractive artistic research practice. We developed an ALife-IML integration by combining two creative AI tools; Tölvera for ALife and Anguilla for IML. Focusing on two artistic works – *Ex Silens*, an immersive performance art piece, and *Strengjavera*, a generative installation – we report on how our co-creative exploration with this hybrid system led us to offering a new descriptor, Intra-Active Perturbations (IAP). The influence of ALife on the learner-teacher relationship common to IML-based workflows gave way to a dialogue of experimentally probing for artistically useful behaviours. We believe this approach has potential in experimental scientific practice, where real-time interaction is under-utilised.

Introduction

ALife, with its roots in the cybernetics of the 1940s and 50s, aims to explore "life as it could be" by studying human-made systems that exhibit behaviors characteristic of natural and living systems (Langton, 1997). In the arts, ALife has been employed for a long time to discover new openings, optimal solutions, evolutionary paths, and innovative answers to problems (Tenhaaf, 2008). Today, ALife continues to play a significant role in the simulation of complex systems, robotics, and the study of artificial biology (Aguilar et al., 2014; Dorin and Stepney, 2024). In recent years, researchers have explored various aspects of "diverse intelligence", such as in the Technological Approach to Mind Everywhere (TAME) framework (Levin, 2022), in non-neuronal learning in physical systems (Stern and Murugan, 2023), and in basal cognition (Lyon et al., 2021).

There is an opportunity for greater compatibility between tools and workflows to facilitate the integration of ALife and interactive machine learning (IML) (Fiebrink and Sonami, 2020; Wondimu et al., 2022) in artistic practice and research. IML allows for ad-hoc investigation and engagement that would be impossible to achieve through interaction with models produced through offline training. The potential for real-time execution of ALife and IML also relates to concurrently running cyber-physical systems, where it is essential to evolve and adapt the system while it is running, rather than shutting down and restarting. The notion of intra-action, as described by Barad (Barad, 2007), emphasises the mutual constitution of entangled agencies, challenging the conventional separation between subject and object. In this context, the system is not meant to be a good student or a servant but a real intra-actor that can inspire the researcher or the artist using the system. It is here where the term pertubation comes in, to describe a dialogue where the activity is not predefined, the solution is not perfectly imagined, and the relationships between participants are dynamic.

This paper presents interviews with the authors of two artistic works, *Ex Silens* and *Strengjavera*, which both leverage the integration of ALife and IML through the Tölvera[1]. (Armitage et al., 2024b) and Anguilla software packages. By examining these works and the creative processes behind them, we introduce the concept of Intra-Active Perturbations (IAP) to describe the emergent dynamics between human and non-human agencies in ALife-IML systems.

Background

Interactive Machine Learning (IML)

Interactive Machine Learning (IML) typically describes human-in-the-loop ML scenarios, where human gestural input, labelling and other forms of feedback are used in the iteration cycle towards a model. Fiebrink and Sonami (2020) provide an insightful overview of how the Wekinator (Fiebrink and Cook, 2010) IML software has been used by Sonami in her gestural digital musical instrument (DMI) design and performance practice since 2012, representing

[1] Website: `https://tolvera.is`
Source: `https://github.com/Intelligent-Instruments-Lab/tolvera`
Install: `pip install tolvera`
Discord: `https://discord.gg/ER7tWds9vM`

a rare case study of long-term, sustained use of IML in artistic practice. Wekinator allows Sonami to easily create complex mappings between sensor inputs and sound synthesis parameters by simply demonstrating examples of input-output pairs (Figure 1), supporting exploration and discovery of new sounds and interactions that would be difficult to achieve through programming alone. Thus compared with other machine learning (ML) approaches, IML favours a "small data mindset" which also avoids the ethical and ecological issues surrounding use of large data sets (Vigliensoni et al., 2022).

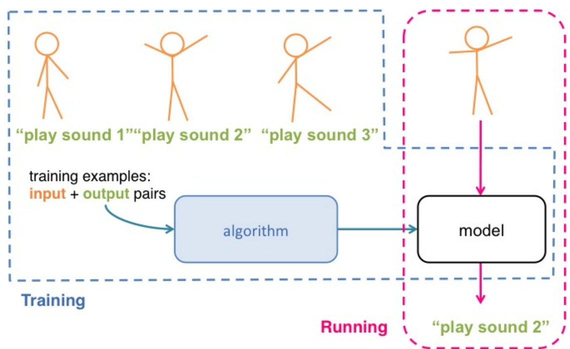


Figure 1: Wekinator workflow diagram and quote from `https://wekinator.org`: "Instead of creating the model function by writing code, you create models by providing training examples of inputs and the outputs that should correspond to them."

Despite the success of IML in the arts, Wondimu et al. (2022) conclude their recent state-of-the-art review by noting the lack of IML exploration in "areas such as searching and retrieval, pervasive computing and robotics, and clustering and optimization tasks, [...] agriculture, health, education, game and entertainment", despite its potential importance being "evidential". Even in the arts, there are few examples (Allik, 2016) that we could find of ALife being integrated with IML.

Diffractive Artistic Research

In their paper on "entangling entanglement", Morrison and McPherson (2024) quote Barad's "optical metaphor" of *diffraction* as enabling the "reading insights through one another in attending to and responding to the details and specificities of relations of difference and how they matter" (Barad, 2007). Diffraction has become an increasingly popular lens through which to probe human-computer interaction (HCI) (Nordmoen and McPherson, 2023), machine learning (Scurto et al., 2021), and indeed ALife (Prophet and Pritchard, 2015), where it brings a healthy problematisation of the boundaries between the natural and the artificial, and eschews any unidirectional idea of "breathing life into" inanimate matter (Prophet and Pritchard, 2015). In our work, this approach has been helpful for us in developing artistic practice and research projects simultaneously, allowing problems and questions to arise out of material-discursive practice.

Intra-Active Perturbations

We agree with Donnarumma that the term artificial intelligence is "haunted by the reductionist and anthropocentric notion of intelligence that was predominant in the 1950s", and that "rather than learning [in machine learning]", often "a more appropriate term would be pattern matching, feature mapping or data averaging" (Donnarumma, 2022). Given this, how should we approach hybrid practice with ALife and IML, and how should other hybrids be described in a way that does not hinder but helps in articulating both practice and research? Diffractive artistic research suggests a mode of engagement with ALife-IML systems that we propsoe could be termed *intra-active perturbation* (IAP); intra-active after Barad (Barad, 2007), and perturbative inspired by experimental scientific practice. This framing departs from conventional notions of interaction, which presume a clear separation and hierarchy between human and machine. And similarly perturbations are not conceived as unidirectional interventions, but rather mutual provocations that reflect the entangled nature of the agencies involved. Such a transition to new terminology potentially facilitates a broader dialogue on human and non-human agential interactions. While IML emphasises the interaction between two distinct entities, an IAP framing recognises the intra-action within ecologies of mutually constitutive human and non-human agencies. Furthermore, this moves away from the learner-teacher paradigm often associated with IML, instead opening to a variety of diverse and dynamic relationships between agencies.

Design

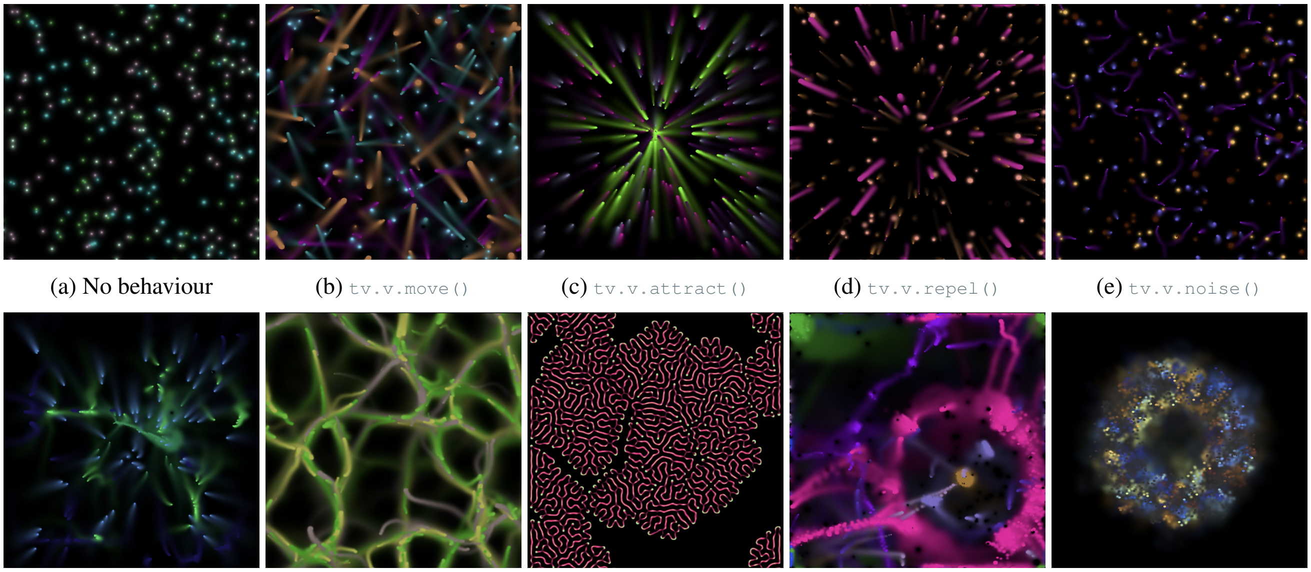
Tölvera and Anguilla are software elements of our research group's *Organium*[2], a library of technical components or elements that can be freely composed together into assemblages, for exploring the embodied notions of intelligent musical instruments. In this section we describe them individually, followed by Anguilla's integration into Tölvera.

Tölvera

Tölvera is a Python library designed for composing together and interacting with basal agencies (Lyon et al. 2021; Davies and Levin 2023). It provides creative coding-style APIs that allow users to combine and compose various built-in behaviours, such as flocking, slime mold growth, and swarming, and also author their own. With built-in support for Open Sound Control (OSC)[3] and interactive machine learn-

[2] `http://iil.is/research/organium`

[3] `https://github.com/Intelligent-Instruments-Lab/iipyper`



(a) No behaviour (b) `tv.v.move()` (c) `tv.v.attract()` (d) `tv.v.repel()` (e) `tv.v.noise()`

(f) `tv.v.flock()` (Reynolds, 1987) (g) `tv.v.slime()` physarum (h) `tv.v.rd()` reaction-diffusion (i) `tv.v.plife()` particle life (j) `tv.v.swarm()` (O'Keeffe et al., 2017)

Figure 2: Examples of behaviours and models available via `tv.v`.

ing (IML)[4], Tölvera interfaces with and rapidly maps onto existing music software and hardware, striving to be both an accessible and powerful tool for exploring diverse intelligence (Levin 2022) in artistic contexts.

A basic Tölvera program that displays a window, and a multi-species particle simulation exhibiting flocking behaviour, can be achieved with just a few lines of code:

```
from tolvera import Tolvera, run

def main(**kwargs):
    tv = Tolvera(**kwargs)

    @tv.render
    def _():
        tv.px.diffuse(0.99)
        tv.v.flock(tv.p)
        tv.px.particles(tv.p, tv.s.species())
        return tv.px

if __name__ == '__main__':
    run(main)
```

In Python, Tölvera is instanced as `tv`, and its main features are all available via the following sub-objects:

`tv.p`: Multi-species particle system, where each has a unique relationship with every other species, including itself.

`tv.s`: Declarative-style global dictionary of n-dimensional (`ndarray`) state structures that can be used by verur, including built-in OSC and IML creation.

`tv.v`: A collection of behaviours/models (*verur*) including Move, Flock, Slime and Swarm, with more being continuously added, that can be combined and composed in various ways (Figure 2).

`tv.px`: Drawing library including various shapes and blend modes, styled similarly to p5.js.

`tv.ti`: GPU simulation and rendering engine via Taichi (Hu et al., 2019). Can be run headless (without graphics).

`tv.osc`: Open Sound Control (OSC) via `iipyper`[5], including automated export of OSC schemas to JSON, XML, Pure Data (Pd), and Max/MSP.

`tv.iml`: Declarative-style global dictionary of IML instances via `anguilla`[6].

`tv.cv`: computer vision via OpenCV and Mediapipe.

Anguilla

Anguilla is a Python package designed around the idea of building mappings from an input space to an output space by way of interactive supervised learning.

In the very small-data regime (Vigliensoni et al., 2022) of IML, rigorous application of machine learning algorithms is often impractical, and at worst counter to artistic intent, which might for example see overfitting as aesthetically desirable. To emphasise interactivity, Anguilla builds on nearest-neighbor search algorithms which don't require a distinct training phase, with mappings defined deterministically by their training data. By removing most complexity associated with the choice of learning algorithm – an accessibility barrier with previously existing IML tools – we hope

[4] https://github.com/Intelligent-Instruments-Lab/anguilla

[5] https://github.com/Intelligent-Instruments-Lab/iipyper

[6] https://github.com/Intelligent-Instruments-Lab/anguilla

to foreground the training data and the interface for creating it.

Anguilla does not provide a user interface itself, but rather a simple API on which applications can be built, with essentially the ability to `IML.add(x, y)` the input-output pair `x, y` to a mapping and `y = IML.map(x)` a new input to an output value.

Anguilla breaks down into three kinds of module: embedding, search, and interpolation. Given a dataset of input-output pairs (x, y), input and output embedding modules maps data to feature vectors $v = f(x)$ and $w = g(y)$. A nearest-neighbor search module maps an input vector $v_q = f(x_q)$ to a set of relevant inputs v from the dataset, where each v_i has distance d_i from v_q, and an associated point w_i in the output feature space. An interpolation module converts the set of distances to a set of weights α for linearly interpolating $w_q = \sum_i \alpha_i w_i / \sum_i w_i$, and finally the inverse output embedding produces $y_q = g^{-1}(w_q)$.

Anguilla's default L2 metric and `Smooth` interpolation module, for example, compute

$$\alpha_i = \frac{1}{d_i} - \frac{d_i^2 - 3d_i D + 3D^2}{D^3}$$

where $d_i = ||v_i - q||_2 + \epsilon$ and $D = \max_i(d_i)$. The $1/d_i$ term ensures that the output interpolates the data, while the rest is chosen to zero the value and first derivative of the weight when $d_i = d_k$, i.e. at the edges of voronoi cells.

A search module is powered by an `Index` object, of which Anguilla currently provides two: `IndexBrute` is a simple pure-Python reference implementation, while `IndexFast` uses the Faiss package (Douze et al. 2024) internally to enable high-throughput operation when, for example, mapping every pixel in an image through Anguilla at once.

Embedding modules f and g can be written to map many kinds of input and output data onto the simple vectors used by the search and interpolate modules – these can be as simple as the identity function, or as complicated as a deep generative model. With Tölvera, for example, an `ProjectAndSort` input embedding enables the use of unordered sets of Tölvera particles as inputs, approximating the sliced optimal transport distance (Bonneel et al. 2015) between point clouds.

The Anguilla API is available from Python, and can also be exposed over open sound control (OSC) for use from music programming environments like Max/MSP, Pure Data, and SuperCollider, via the `iipyper` package.

Tölvera-Anguilla Integration

To make IML as accessible and simple to use in Tölvera, it features a global dictionary of Anguilla instances at `tv.iml`. IML can be used for a wide range of purposes in Tölvera, including creating internal feedback loops:

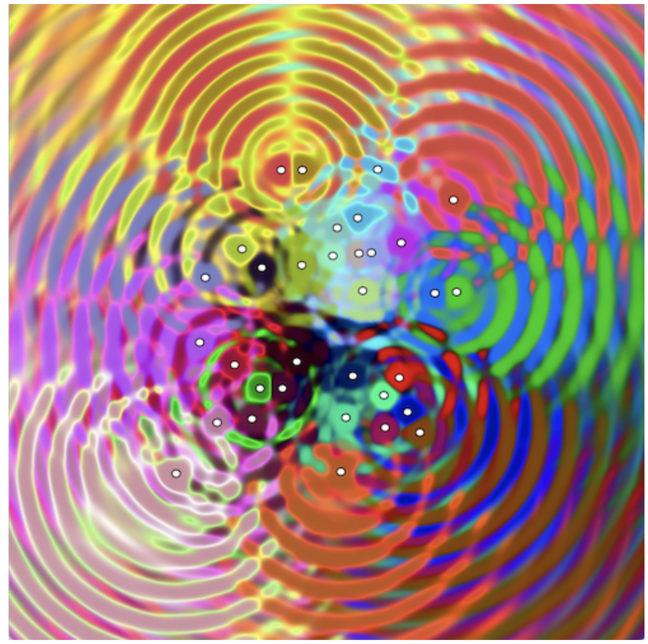


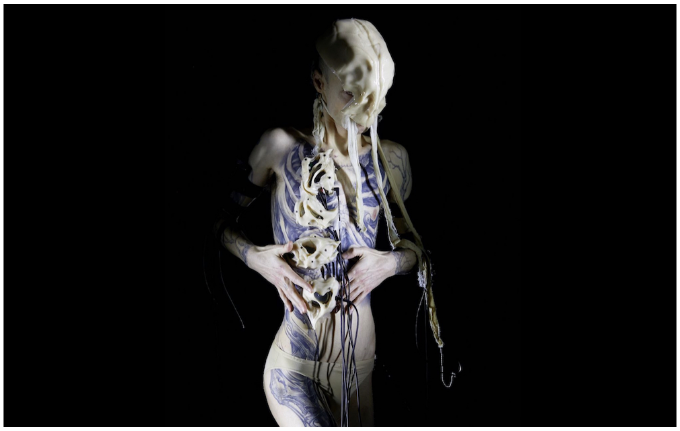
Figure 3: Real-time visualisation of `tv.iml` for 2D input (XY axes) and 3D output (pixel RGB) demonstrating Anguilla's ripple interpolator, with input-output pairs shown as white circles.

```
tv.iml.flock_p2flock_s = {
  'size': (tv.s.flock_p.size, tv.s.flock_s.size),
  'io': (tv.s.flock_p.to_vec, tv.s.flock_s.from_vec)
}
```

In this example, we map `tv.v.flock`'s particle states (`tv.s.flock_p`) to the multi-species rules states (`tv.s.flock_s`), which in turn alter the particle states. The input and output methods specified in the `io` property will be run in the background by Tölvera. These are `to_vec` and `from_vec`, built-in methods that serialise and deserialise state to/from 1D arrays making them suitable for use as IML input/output vectors. Input and output can be either a vector, function or OSC endpoint. Notably, these IML maps can be trained and updated on-the-fly, providing more variation in prolonged usage. Figure 3 demonstrates how Tölvera's state and drawing capabilities can be used to enable real-time visualisation of IML maps.

Artworks

In this section we describe two artworks – *Ex Silens* by Marco Donnarumma, and *Strengjavera* by Jack Armitage – that combined Tölvera and Anguilla. In *Ex Silens*, ALife and IML are used to control robotic prosthetics and ML-based sound engines as part of a performance piece, with no visual component coming from Tölvera. In contrast, *Strengjavera* presents a visualisation of ALife-IML feedback loops, as part of a generative installation involving an electromag-



(a) *Ex Silens*, by Marco Donnarumma, premiered at CTM Festival in Berlin, January 2024.

(b) *Strengjavera*, installation with magnetic resonator piano, premiered in August 2023.

Figure 4: *Ex Silens* and *Strengjavera*, the two artworks discussed in this paper that both use Tölvera and Anguilla.

netically augmented grand piano. As we have already mentioned, the development of both tools has been concurrent with artistic practice, a methodological choice that we see as crucially and critically informative towards the design process, leading to different outcomes compared with developing tools before practice, or developing tools for scientific aims and then pursuing their artistic exploitation.

Subsequently reflecting on artworks to inform technological design iterations is also key to our approach. This section therefore builds on "diffractive dialogues" with the authors, where each responded to "a series of discussion prompts by drawing on [their] own disciplinary backgrounds" (Morrison and McPherson, 2024). In particular, the authors were questioned about intra-actions and perturbations within their pieces.

Ex Silens

Marco Donnarumma premiered *Ex Silens*[7] (Figure 4a) at CTM Festival, February 2024, Radialsystem, Berlin, Germany. The programme note reads:

> *What is deafness if not another mode of perception? What is a cyborg if not an exploded mirror of today's corporeal experience? What is the fear of the other if not a prelude to isolation? What is the instability and interdependence of the human body if not the core of its existence?*

Ex Silens involves haptic prosthetics that represent sound based on his *Xth Sense* platform (Donnarumma, 2011), which resulted from workshops with deaf people where sound was experienced through the body. Donnarumma applied the technology in a performance piece that addressed hearing and deafness. Donnarumma (**MD**) was interviewed by Armitage (**JA**) about the piece, its development, and its relation to his recent writings on critical AI aesthetics (Donnarumma, 2022). On his use of ALife-IML in Ex Silens, Donnarumma relayed:

MD: I'm using four particles that are in a group, fairly tight together, and they move around this 2D space, and then their positions are mapped with anguilla to these 2D data sets [of sound corpora]. So I can imagine more or less where they are moving by hearing the sound they are producing, but I cannot account for any sudden change that they may do. And this gives me very good motivation to interact with them in a much more credible way, because I really do not know what to expect from them.

Donnarumma manipulated spatial boundaries in real-time to coax the particles into certain areas, in order to indirectly gesturally control sound. Rather than describing the piece by breaking it down systematically into component elements, Donnarumma described his experience of combining Tölvera and Anguilla through metaphor, saying "it feels like I'm blowing on a dandelion, trying to get the little seeds [IML input-output pairs] flying here and there [...] I'm encouraged to interact in very delicate ways with it". Rather than a direct manipulation-style relationship, Donnarumma related that "there is this kind of distance, but it's a distance because you don't want to break the thing [mapping]". A thought experiment was put to Donnarumma:

JA: If you took Tölvera out of the ecology, how do you think that would perturb the piece?

MD: The prosthesis would be much less credible if I would remove Tölvera. I could not have the prostheses behaving or speaking as organically as they do now. I could possibly program a sort of randomiser or whatever, but that would take me ages, and would also not be the same thing

[7] `https://marcodonnarumma.com/works/ex-silens/`

as Tölvera. Tölvera enlivens these prostheses, makes them like alive creatures. This then, at the level of the performance, gives me very good motivations to interact with them.

At a higher level, Donnarumma described his ecologically-informed approach in *Ex Silens*:

MD: What interests me is this relational framework, in the sense that it's embedded in an ecology of components that are situated in the real world. And the real world includes people as components. In my case, I like to do that by connecting the body to the software. In *Ex Silens*, it's a lot more explicit [than in MD's previous works] because the whole piece is based on relations. There is the relation between the performer and the audience, between the prosthesis and the performer, and the prosthesis, the audience and the performer, and the prosthesis and sound, and so forth. And the piece would not exist if those relations were not performed in real time throughout the piece itself. These prosthesis are designed to relate with as many other people as possible to different sounds, to different surfaces, to different environments. And by relating these, then they can also create links with all these elements among people and so forth.

Strengjavera

Armitage premiered *Strengjavera* (Figure 4b) at the AI Music Creativity (AIMC) Conference, August 2023, University of Sussex, Brighton, UK (Armitage, 2023). In the piece, a magnetic resonator piano (MRP)[8] (McPherson, 2010) exists in a feedback loop with Tölvera and Anguilla, controlled via a Python package `iimrp`[9] developed for the MRP. A piezo sensor was used to analyse the piano soundboard, via a version of Flucoma (Tremblay et al., 2021) compiled for Bela[10] (Moro et al., 2016). One Anguilla instance mapped MRP audio features to Tölvera's multi-species behaviours, and a second instance mapped Tölvera particle positions to a vector of frequencies. Using the `iimrp` package, these frequencies were used to search over the 88 keys $\times$ 16 harmonics for the N nearest harmonics on the piano, which were faded in and out together as detuned clusters. Input-output data pairs were also added dynamically to the Anguilla instances, giving the piece further temporal diversity.

One viewer noted "I found myself in the cycle of organic attraction and repulsion, decay and integration, independence and cooperation, beginnings and ends in organized disorder, purposefulness of randomness". As well as interviewing Armitage (**JA**), researcher and colleague Miguel Crozzoli (**MC**) discussed his experience of witnessing *Strengjavera*:

[8] `http://iil.is/research/mrp`

[9] `https://github.com/Intelligent-Instruments-Lab/iimrp`

[10] `https://github.com/jarmitage/flucoma-bela`

MC: The strings of the piano, in resonating frequencies, expand and collapse, building upon each other's resonant spaces. One being is made from multiple resonating bodies, stretched, and tensed, and multiple beings are composed in one resonant body, in a dynamic flow. Movement can be listened to interacting in a coherent consonant sphere, which falls into a relational environment of partials within and against each other. Is this a collective voice or a murmuration of entities?

MC: For me [being from Argentina], the relationship that I have with a piano is quite different from the relationship someone from Germany has for example. Even though it's a beautiful instrument, the historical context is loaded with different things. So when I entered the room [...] the installation had a lot of political connotations.

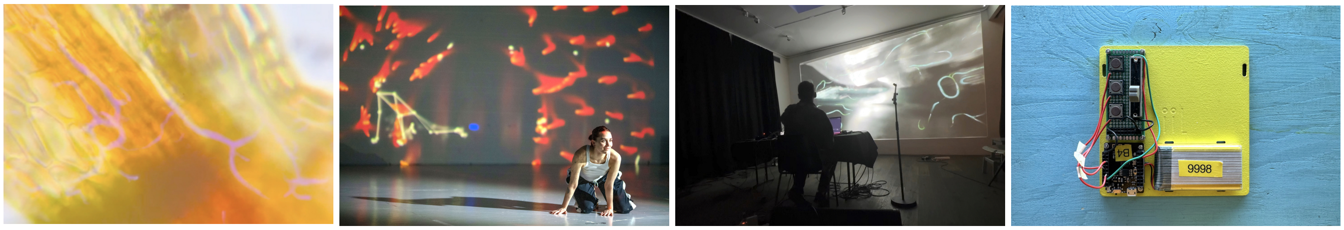
JA: The piano is definitely an intimidating, iconic figure. I wanted to use the piano in an unusual way, getting away from the tuning system that it's bound to, and a note as something with a discrete beginning and end. Those assumptions are gone in this piece. I'm trying to create space for reinterpretation of the piano. If you take the piano but forget about the keys, tuning and hammers, and look at it as a purely acoustic object, then what is its musical potential starting from there?

MC: I think that the installation addresses in a very sensitive way this idea of decolonisation. For me, Tölvera in this piece, is not just a technological tool, but a medium to explore and voice otherness through an entangled relationship with the MRP. It's like if our vocal chords could communicate with ourselves, and then we have this feedback communication system [within ourselves]. In the context of a generative installation, and talking about political implications, I think one of the beautiful ideas is this decolonisation of the piano, that there was a piano player sounding beautiful without a piano player. Could you elaborate on this relationship of voicing the otherness, the piano without the piano player?

JA: The technical architecture of the piece led this relationship in a certain direction. There's an error between the frequencies that are chosen based on particle movement and the piezo's sensed frequencies, and that difference is a key part of the dynamic. It is about this bridge between our digital systems and the physical world, focusing on that error or difference and magnifying that separation.

MC: I was wondering if there's a narrative within the piece, even the narrative not attached to form, but maybe with these political intentions or narrative in a broad sense.

JA: I do see it as a commentary on the state of AI in society and how we are engaging with it. What I'm trying to do is provide alternatives, to broaden the scope of the discourse, to include more collective intelligences. I'd like



(a) Örvera (“microbe”) slime model & real-time microscopy.

(b) Hreyfivera (“moving being”) with choreographer Júlía Kolbrun.

(c) Gagnavera (“data being”), exploring live coding with Tölvera.

(d) Tangible UI via Organium elements.

Figure 5: *Tolvera Suite* works-in-progress exploring new features including computer vision, gesture detection, live coding and physical learning interfaces.

people to, in the end, be able to take the machine learning-based AI that we see all around us today and be able to put it in context.

Discussion

Emerging Themes from ALife-IML Art Practices

The artistic practices explored in *Ex Silens* and *Strengjavera* suggest a mode of engagement with ALife-IML systems that we have suggested to term *intra-active perturbation* (IAP). In *Ex Silens*, the prostheses are enlivened by Tölvera, becoming organic, unpredictable agents that the performer must relate to in real-time. The piece emerges from the intra-actions between performer, prostheses, sound, and audience, situated in a shared ecology. Similarly, in *Strengjavera*, the entanglement of Tölvera’s particles with the resonating strings of the piano creates a single emergent entity, despite the apparent visual and auditory separation. For artists, we see this approach as offering a way to explore creative potentials at the boundaries of human and non-human agency, and to enact critical interventions. An open question in our research is how this creative practice might inform or inspire approaches to scientific practice, which often centres around offline simulation, with real-time interaction only added at the end for surveying results.

The artistic practices explored in *Ex Silens* and *Strengjavera* reveal a common theme of relating to otherness through the integration of ALife and IML. This was explicit in *Ex Silens*, where Marco Donnarumma described the prostheses as an other that he had to engage with in a delicate, non-dominating way. In *Strengjavera*, the theme of otherness emerged through Crozzoli’s probing interview, interpreting Armitage as decolonising the piano by using it in an unusual way, getting away from its traditional tuning system and discrete notes. This decolonial approach to the piano could be connected to the idea of decolonial listening as a practice that challenges dominant “aural regimes” and attends to marginalised sounds and stories (Castellanos, 2023).

Future Work

Figure 5 depicts some of the ongoing artistic research with Tölvera and Anguilla. In the piece Örvera (Figure 5a), we are integrating computer vision (`tv.cv`) to create hybrids between ALife and wet life. In Hreyfivera (Figure 5b), we are integrating Mediapipe[11] to explore choreography. In Gagnavera (Figure 5c), we are exploring live coding of ALife (Tran, 2023) via the tool Sardine (Forment and Armitage, 2023) We are also exploring tangible interfaces to Tölvera (Figure 5d) via our *Organium* library of technical elements, and sonification via integration with SignalFlow[12] (Armitage et al., 2024a). There are also plans to explore robotics[13] and 3D printing via FullControl (Gleadall, 2021).

We are also undertaking community building activities such as pedagogical workshops and hackathons, and writing more examples and documentation. Already this has resulted in valuable feedback about how to improve Tölvera’s API design to find the balance between rapid out-of-the-box results with deep customisability. Tölvera’s collection of behaviours and models will also hopefully expand, in particular we are interested in adding neural cellular automata, which have already been implemented in Taichi (Barbieux and Canaan, 2023).

Conclusion

This paper has explored the creative potentials that lie at the boundaries between human and non-human agency through the commingling of artificial life (ALife) and interactive machine learning (IML). The hybridisation of two creative tools – Tölvera for ALife and Anguilla for IML – enabled situated explorations across disciplinary contexts in the artistic works *Ex Silens* and *Strengjavera*. The concept of *intra-active perturbations* was introduced to describe the mode of engagement with ALife-IML systems, departing from the archetypal teacher-student relationship in IML, and recognising the mutual provocations that reflect the entangled nature of the agencies involved. We invite artists and researchers to perturb this term further, and join in the pro-

[11] `https://developers.google.com/mediapipe`

[12] `https://signalflow.dev`

[13] Which Sardine has also been used for: `https://theaterlabnyc.com/together-apart-january-6-7-2023/`

cess of developing flexible and open-ended language around their emerging practices. We suggest that the successful application of this hybrid approach in artistic research practice opens up the possibilities for new approaches for scientific practice focusing on real-time interaction with experimental processes.

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