

The Accusations That Are Confessions: Improvisation, Embodiment, and Human-Machine Learning

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Additional Key Words and Phrases: embodied music cognition, enactive-ecological approaches, live electronic musical improvisation, machine-listening, machine-learning.

1 Program Notes

Exploring instability, vulnerability, and unpredictability, this performance is the latest in a series of improvisations formed out of playful and tactile explorations of my now almost twenty-year-old hybrid analogue-digital live electronics performance system, which comprises self-built software, voice processing, drum machines, and repurposed controllers. An excessive number of components, of which the space, audience, and performer are all part, mutually affect each other through a network of sound analysis and digital signal processes. Improvisation with the system, and as a practice, is experienced as a dynamical system, an embodied machine-intelligence, a sensuous and sensorial way of being in the world. As part of the selection representing the USA, *The Accusations That Are Confessions* was premiered at the 2024 World New Music Days, Faroe Islands.



Fig. 1. Performing *The Accusations Are Confessions* at High Desert Soundings Festival, 2025. Photo: Tobias Feltus.

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2 Project Description

The Accusations That Are Confessions (2024) is a musical improvisation for embodied human-machine learning. This involves a methodology that is myriad and maximal in its relationship to sound synthesis and music production that has evolved over the last nineteen years. That is to say that it is ambivalent about particular or specific synthesis techniques, dominant lineages of electronic music, or purist ways of working with digital sound. Instead, this research project conveys an approach to interface design, digital sound manipulation, and music production as a way of knowing. It does not discriminate on the techniques that are used. Many types of synthesis from frequency modulation, amplitude modulation, subtractive synthesis, pulsar synthesis, and micro-sonic techniques are messily accumulated into the performance system alongside elements such as machine listening, machine learning, sampling, live re-sampling, analysis and resynthesis, and other approaches to the creation and transformation of digital sound. Yet this work follows philosopher and cognitive scientist Hanne De Jaeger in her resistance to privileging what I will sum up in brief as the ‘computational’ language that is often used within cognitive science research; she asserts that “our most sophisticated knowing is full of uncertainty, inconsistencies, ambiguity, contradictions” [1, p848]. Informed by enactive-ecological [8], and embodied approaches to cognition, it is the very non-linear complexity of being a living, encultured human navigating the world, encountering materials, and embodying processes that informs this way of engaging with sound and performing live electronic music (see [3]).

This NIME–continuously evolving since 2007–is a hybrid analogue/ digital performance system that includes laptop, custom software written in the graphical creative coding language Max, controllers, voice processors, drum machines, analogue synths, which all mutually affect each other by way of the ecological software design and machine listening techniques (see [4]). This creative practice is deeply informed by the theories of embodied music cognition, specifically the enactive-ecological approach [5]. In this, the affordances of my system are not cerebrally mapped out, but are explored–and music is produced–via the dynamic, playful, and ongoing navigation between myself and the system.

The design of the enactive-ecological performance system (see Figure 1) is informed by early models from cybernetics and artificial life and has explored notions of feedback, unpredictability, autopoiesis, and dynamic systems. As musician and scholar Tara Rodgers has noted, “To take seriously [an] analogy between sounds and forms of life-as fleeting, overlapping, and ever in transformation-requires that we dismantle the subject position of detached and knowing observer that persists in audio-technical discourse, and recognize ourselves amid the currents, always provisionally defined in relation to other humans, species, things and environments” [9, p209]. In the case of the human, the design has been shaped by the many communities of practice that I have participated in over these years, by way of friends, mentors, educators, students, collaborators, workshop leaders, workshop participants, community groups, ensembles, research groups, and so on.

More recently, this performance system has incorporated machine learning and complex sound decomposition techniques as part of my participation in the Fluid Corpus Manipulation (FluCoMa) research project, University of Huddersfield [10]. Within this community of practice, I was commissioned as one of eight international artists to create a new work using the creative coding toolkit. The project studied how creative coders and technologists work with and incorporate new digital tools for deconstructing audio in novel ways. This project allowed me to explore if and how machine learning could be used to augment my already mature improvisational system in Max, and how this could be embodied through performance practice.

In this performance, I implement and perform a technique that I describe as ‘third-order improvisation’. Firstly, I perform and record an improvisation using my hybrid analogue/digital system. This may involve, for example, vocals that have been live sampled and processed in a variety of ways (see, for example, video Figure 2, 11m 00s), drum machine sounds, or synthesis created within Max, all of which are continuously analysed in real-time, along with gestural information from a game controller. Next, I segment the recording based on factors such as FluCoMa’s ‘novelty’ algorithm (see [10]) or transient detection, I order the segments according to a variety of descriptors including pitch, loudness, and spectral shape, and then I re-improvise with this ordered material using k-nearest neighbour (KNN) algorithms within FluCoMa to create punchy percussive and rhythmic patterns that I can move away from gradually–or rapidly–into new sonic territory. This second pass is also recorded. This technique was used substantially in my 2021 EP, *Embrace* [Superpang] on the tracks *Xeon* and *Kill The Cop In Your Head* (see [6]), where this type of exploration of repetition, suggestion, and evolution of sound is evident.

Finally, this material is then re-improvise live via another similar, but simplified KNN-based approach that is tailored towards real-time performance and omits various computationally intensive analysis elements. In this third pass, second-order material is re-animated and becomes part of the live performance (see, for example, video Figure 3, 8m 48s). A full discussion of my use of FluCoMa within my instrument development, along with code examples, can be found at [2].

This performance seeks to question, challenge, and reshape the established protocols of sound synthesis and electronic music performance by drawing inspiration from the enactive-ecological framework, incorporating the historic, emergent,

and structurally-coupled relationships between musical agents, materials, and sounds. In her work on digital musical instrument design and "embodied autoethnography" [7], musician and scholar Mary Mainsbridge exemplifies this process, stating: "I refine the instrumental and expressive capacity of my body as it develops through varied activities and phases" [7, 5].

This project explores live electronic musical performance and sonic art through this historic, encultured, and very much embodied lens. It is not the technological developments that are necessarily of importance within this practice: it is the socio-musical configurations that are reified within the embodied performance of such techniques that hold the most potential for creating new (musical) worlds.

3 Technical Notes

The typical duration of this improvisation is 23 minutes. The duration is determined by the structure of the musical material.

The full technical rider with requirements and stage plan is available on request.

4 Media Links

- Video: <https://youtu.be/RgPaHgbaevQ>



Fig. 2. Excerpt from *The Accusations That Are Confessions*, NYC Electroacoustic Improvisation Summit, CUNY City Tech Entertainment Technology Department, Brooklyn, NY, USA, 2025. Click the image to visit the video.

- Video: https://youtu.be/Rbz9XxU_9nM



Fig. 3. *The Accusations That Are Confessions*, Wavetable, Edinburgh, Scotland, 2025. Click the image to visit the video.

5 Biography

Lauren Sarah Hayes is a Scottish improviser, sound artist, and scholar who is recognised for her embodied approach to computer music. Her music is a mix of experimental pop/live electronics/techno/noise/free improvisation and has been described as "voracious" and "exhilarating". Her performances stretch, transform, and sculpt sound by manipulating, remixing, and bending voice, drum machines, analogue synths and self-built software live and physically. Her shows are

highly gestural, exploring the ephemeral and fragile relationships between sounds, spaces, and audiences. Over nearly two decades, she has developed and honed her live electronics improvisation system, an instrument that allows her to playfully navigate between the realms of responsiveness and unpredictability in both her solo performances and numerous collaborations.

She has been commissioned by major festivals including the London Jazz Festival, the Huddersfield Contemporary Music Festival with a live BBC Radio 3 broadcast as part of its 2017 International Showcase, and Sonica, for which she gave four sold-out performances inside Hamilton Mausoleum, Scotland, famous for once holding the longest echo of any man-made structure. She has performed extensively across Europe and the US, including at Moogfest, World New Music Days (USA selection 2024), and as part of her tenure with the New BBC Radiophonic Workshop at Kings Place, London. The Wire described her 2016 album MANIPULATION (pan y rosas discos) as “skittering melodies and clip-clopping rhythms suggesting a mischievous intelligence emerging from this web of wires”. Reviews of her acclaimed 2021 release Embrace (Superpang) called it “sensual and frenetic”, “a kind of religious joy”, and “profound talent breaking new grounds”. Her music has been released on Superpang, Hard Return, Pan Y Rosas Discos, LOL Editions, Werra Foxma, Sunwarped, and Harmonic Ooze Records. She is currently Associate Professor of Sound Studies in The GAME School, Herberger Institute for Design and the Arts, Arizona State University.

6 Ethical Standards

This research project involves the creative practice of the author. No further ethical consent was required.

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References

- [1] Hanne De Jaegher. 2021. Loving and knowing: Reflections for an engaged epistemology. *Phenomenology and the Cognitive Sciences* 20, 5 (2021), 847–870.
- [2] Jacob Hart. 2022. Event Detection and Improvisation. <https://learn.flucoma.org/explore/hayes/>.
- [3] Lauren Hayes. 2019. Beyond skill acquisition: Improvisation, interdisciplinarity, and enactive music cognition. *Contemporary music review* 38, 5 (2019), 446–462.
- [4] Lauren Hayes. 2022. Why Should We Care about the Body?: On What Enactive-Ecological Musical Approaches Have to Offer. In *The Body in Sound, Music and Performance*. Focal Press, 23–34.
- [5] Lauren Hayes and Juan M Loaiza. 2022. Exploring Attention Through Technologically-Mediated Musical Improvisation: An Enactive-Ecological Perspective. *Access and Mediation: Transdisciplinary Perspectives on Attention* 11 (2022), 279.
- [6] Lauren Sarah Hayes. 2021. Embrace. Streaming. <https://laurensarahhayes.bandcamp.com/album/embrace> Superpang.
- [7] Mary Mainsbridge. 2022. Feeling movement in live electronic music: An embodied autoethnography. In *Proceedings of the 8th International Conference on Movement and Computing*, 1–7.
- [8] Erik Rietveld, Damiaan Denys, and Maarten Van Westen. 2018. Ecological-enactive cognition as engaging with a field of relevant affordances. *The Oxford handbook of 4E cognition* 41 (2018), 70.
- [9] Tara Rodgers. 2016. Toward a Feminist Epistemology of Sound. *Engaging the World: Thinking after Irigaray* (2016), 195–214.
- [10] Pierre Alexandre Tremblay, Owen Green, Gerard Roma, and Alexander Harker. 2019. From collections to corpora: Exploring sounds through fluid decomposition. In *International Computer Music Conference and New York City Electroacoustic Music Festival*. International Computer Music Association, 223–228.