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Bacteriophage in Granular Waves

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Bacteriophage in Granular Waves **is a musical work and performance that adopts data-driven composition methods, generative systems and sonification techniques to produce a musical work from a synthetic virology dataset. It has emerged from a larger collaboration exploring creative and artistic strategies for the visualization and sonification of virology data. The system employs agent-based modelling to draw samples from the dataset and uses waveshaping and granular synthesis methods to map these data to musical parameters. The end results is a performance that is always in flux where simple waveforms are sliced into tiny sections and reconfigured into texturally rich tapestries that interweave through one another shifting and unfurling in response to the virological parameters represented in the data.**

Overview of the Piece

Bacteriophage in Granular Waves is a data-driven musical performance that employs generative sonification techniques to map synthetic virology data to musical parameters. It is the result of initial steps towards the development of a more generalised system for sonifying viral genomics data for contexts in biomedical analytics and education. The data was created in-silico and modelled after the characteristics of viral bacteriophages we might expect to find in human tissue samples. The data of interest are base pair (bp) length and coverage values which are measures of the physical length of the double helix for a given DNA strand and the completeness of the genomic sequencing process respectively. While coverage gives a sense of how much of a given bacteriophage is present in a sample, the bp length of a viral genome provides an indication of the size and, to some extent, the complexity of a given virus. The system maps the data to control the parameters of a generative system, specifically an agent-based model simulation consisting of an ecosystem of autonomous agents where each agent represents a unique bacteriophage in the dataset.

The agents are engaged in simple target seeking behaviours in a 2D environment, intermittently passing through a ‘bacterial hotspot’ which causes their data associated to be passed to the sound synthesis routines. Their speeds and steering rates are determined by the data. This simulation is visualised and projected live during performances. Agents entering a hotspot send their midi notes to wavetable synthesis routines to produce a signal. The first round of sound synthesis mappings is focused on representing the data at the timbral level. Synthesis parameters are mapped to the data to ensure that the audible clarity of the sound produced is driven by the coverage while the spectral complexity is mapped to bp length. These signals are sent to granular synthesis

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routines for further processing. At this layer data are mapped to represent the data at the textural layer with coverage defining the audible clarity of the textures while bp length defines the textural complexity of the sound. The result is a rich sonorous soundscape that operates as an aesthetic experience of the data as rendered to sound by a data-driven generative music system.

Fig. 1. Performance at AMICAD 2025.

Aesthetically the system is informed by George Lewis' (2000) *Voyager system*, Iannis Xenakis' (1967) algorithmic compositions (e.g. *Pithoprakta*) and Brian Eno's *Discreet Music*. From the sonification point of view Fitch & Kramer's now infamous paper "Sonifying the Body Electric" provides a key motivation specifically in its introduction of the concept of 'piggybacking' multiple streams of data onto the parameters and behaviours of a single sound object.

There are several interconnected motivational dynamics at play in the design and expression of this piece while the technical and aesthetic have been explored in depth elsewhere (Roddy et al., 2026), the piece is considered here from a more theoretical point of view. *Bacteriophage in Granular Waves* concerns itself with questions of agency, scale and complexity. Bacteriophages are viruses which exclusively target bacteria. While bacteria are living single-celled microorganisms, the viruses that prey upon them are neither living nor dead but rather a unique category of thing (possibly agents) that exists on the periphery of biological life.

The question of whether a virus can be said to have agency is a complex one, not least because the traverse their environments in a random and passive manner. In this piece I choose to foreground this tension framing the bacteriophage as agents by employing the agent-based-modelling techniques to represent the viral data, while also retaining the randomness in the motion of these agents. As can be tracked in the visuals, the viral agents move at random across their environment re-

leasing their data as sonic information when they encounter a viable bacterial host, denoted by the green agglomeration at the centre of the screen as per Figure 2. The amount of data that any one virus releases is minimal given that they only carry the aforementioned values for bp length (as a proxy for viral complexity) and coverage (counting the number of times a virus appears in the sample). These small chunks of data layer upon one another building in complexity when they are sonified and the scale of the data is finally revealed as a play between clarity and complexity across timbral and textural layers. The final aesthetic effect here is one of that flows between intense claustrophobic anxiety and a more open and voluminous expression. The soundworld conjured by the interplay of virus and bacteria is a direct reflection of the danger that a given viral bacteriophage poses to the bacteria represented at the centre of the audiovisual world conjured.

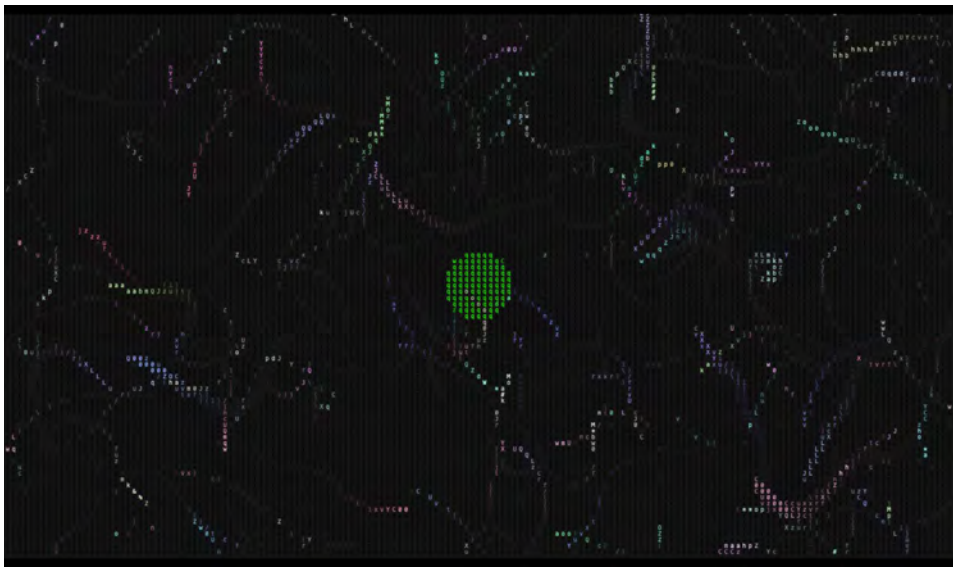

Fig. 2. Visual Component.

Conceptual Discussion

Conceptually the piece is aims to address itself to the question of biologically inspired computing in cultural practices in the wake of AI. AI in this regard is more accurately characterised as neural network based machine learning (NNbL), itself a form of biologically inspired computing that builds on the concept of the artificial neuron. For some time now we have been living through a moment defined by these biologically inspired computing systems. Critics have highlighted the litany of negative social, political and ecological externalities that come with the establishment of large scale NNbML infrastructures. N Katherine Hayles sketches an outline of a post NNbML future that is strikingly relevant in the context of this current work in her recent book Bacteria to AI: Human Futures with Our Nonhuman Symbionts (Hayles, 2025). Hayles' conceptual apparatus in the form of *Technosymbiosis* along with Yuk Hui's notion of *Technodiversity* (Hui, 2023) have been extended to conceptualise sonic arts practices that diverge from the hegemonic tendencies of distributed NNbML infrastructures (Roddy & Bridges 2024;

Roddy & Parmar 2023). *Bacteriophage in Granular Waves* is positioned as a response to NnbMl trends in the sonic arts as a musical work drawing on biologically inspired computing without the negative externalities associated with NNbML.

Additional Information

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