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Uncertainty as Spectacle: Real-Time Algorithmic Techniques on the Live Music Stage

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When performing live, musicians often tread on the verge of messing up to entice their audiences. The audiences' expectations of failures serve as the backdrop against which musicians enact the spectacles of suspense. By explicating the techniques of live looping to live coding, this article excavates how real-time algorithmic techniques refashioned conceptions of musicianship, wherein musicians come to embrace the speculative possibilities of failures against the ontological uncertainty inherent to these algorithmic processes. Drawing on the indeterminate nature of these algorithmic techniques in real-time operations, this article sketches out a reorientation toward an ethics of algorithms that anticipates and prepares for failures as always probable.

Keywords: liveness, temporality, algorithms, uncertainty, failures, expectations

When performing live, musicians have a push-and-pull dynamic with failures. On the one hand, they strive for precision and stability by avoiding mistakes—by hitting the right notes and staying on the beat. Yet, to reify the "live" against the supposedly lifeless, musicians constantly tread on the verge of messing up. They try at something dicey that demands mastery of their craft. When a guitarist attempts a complex riff, it becomes a spectacle of corporeal musicianship—precisely because their audience anticipates that it could very well turn disastrous.

From live looping to live coding, real-time algorithmic techniques complicate musicians' relationships with failures during live performances. While technologists often tout the promises for computer algorithms to contain the risks of failures by bringing in a greater sense of stability and precision (Galison, 1994; Wiener, 1950), musicians often hold a vacillating attitude toward algorithmic techniques for live music performances. They worry these techniques might render their performances all too predictable, to the point that they lose the thrill of uncertainty that is constitutive of their musicianship (Armitage & Thornham, 2021; Briones, 2022; Cocker, 2016, 2018). They also fear that these techniques might make their performances all too unpredictable, where they lose their corporeal control over their expressions. Musicians' ambivalence sheds light on the Janus-faced nature of algorithmic processes in real time—where

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they reduced some risks and introduced new uncertainties, ushering in new forms of expressivity while supplanting existing senses of control.

Liveness and Musical Authenticity

To understand how real-time algorithmic techniques come to refashion musicianship, one must first genealogically situate the shifting conceptions of liveness and their relationships to musical authenticity. As Philip Auslander (2012) remarked, liveness is "not an ontologically defined condition" (p. 3); its conception is ever-shifting, historically contingent, and technologically specific. Before recording technologies, all music performances were live—"there was no need for a category of 'live' performance, for that category has meaning only in relation to an opposing possibility" (p. 3). For instance, conceptualizing the ancient Greek theater "live" would be an anachronism (Fritsch & Strötgen, 2012), as there was no possibility of reproducing such performances via recordings.

It was against the advent of recording technologies that liveness emerged as a defining emblem of musical authenticity (Auslander, 2022; Baym 2018; Thornton, 1996). With the proliferation of recorded music since the early 1950s (Gracyk, 1997; Katz, 2010), musicians' ability to satisfy their audiences' imagination of "music-producing bod[ies]" became the means through which they authenticate themselves as legitimate (Fritsch & Strötgen, 2012, p. 51; see also Hewitt & Knowles, 2012). Particularly in the rock, pop, and classical traditions, musicians would attempt to *replicate* their recordings in live performances (Gracyk, 1997; Katz, 2010; Mulder, 2015), even when the music "that was pieced together in the recording studio had not necessarily ever been performed in real-time" (Auslander, 2022, p. 82).

With such pursuit of liveness as musical authenticity, techniques like playbacks and Auto-Tune also emerged as means to "perfect" live music performances. Against this backdrop, liveness, in turn, was relocated from the pursuit of replications to the *enactment* of shared moments (Bourdon, 2000; Butler, 2014; Thornton, 1996). From experimenting with a new arrangement to inviting a fan to perform on stage, musicians began authenticating themselves on the live stage by producing a "now here together" (Hammelburg, 2021)—the sense that the musicians and their audiences are sharing a unique event in the live instance. To enact such shared instances, liveness has particularly come to be marked by *uncertainties* (see Scannell, 2014), which elevated the realms of live performances into *spectacles of suspense*. Against techniques that can replicate the "perfect" recordings on live stages, musicians turned to entertain the possibilities of failures to reify their authenticity. In other words, performing live came to mean constantly treading on the verge of messing up.

More recently, with the increase in computing and signal processing power, as well as the uptake of Musical Instrument Digital Interface (MIDI) since the mid-1980s, it became possible for musicians to configure their expressions through computational means in real time on the live stage (Hewitt & Knowles, 2012; Kjus & Danielsen, 2016). This is exemplified by the figure of the "laptop musicians" (Auslander, 2022; Butler, 2014). Beyond moving their bodies, uttering voices, and playing instruments, musicians would reify their musicianship by triggering audio samples and recalling time-based effects.

Yet as "the computer does not require that the user possess the traditional craft skills associated with musicianship (Auslander, 2022, p. 107), musicians began searching for new ways to enact the spectacles of suspense. To this end, they relocated their expressivity to "passion-of-the-knob moments" (Butler, 2014, p. 101)—where musicians direct "exceptionally intense expressivity toward a small, technical component associated with sound engineering" (p. 101). In this case, the spectacles of suspense are visually and corporally constructed, wherein musicians finesse their control over computerized expressions through their fingers, hands, feet, or other body parts. This is especially evident in the disk jockey (DJ) tradition in electronic and hip-hop forms.

Real-Time Algorithmic Techniques: Ontological Uncertainties and Speculative Possibilities of Failures

Other than introducing the knob-tweaking musicians, the computerization of sonic production also brought the techniques of real-time *algorithmic* configurations to the live stage, such as live looping and live coding. These techniques gave rise to a new terrain of live sonic expressivity rooted in the speculative possibilities of failures. Like playbacks and Auto-Tune, real-time algorithmic techniques similarly echo the promise to stabilize live sonic expressions. Yet, these algorithmic techniques are *always already* linked to an ontological quality of indeterminateness in their real-time operations (Amoore, 2020; Ananny, 2024; Galloway, 2006; Parisi, 2013). Indeed, when leveraging algorithmic techniques in live contexts, musicians may never know for sure how the algorithmic mediations may play out, despite having a general sense of how these processes operate.

Traditionally, the possibilities of musical failures manifest *corporeally*—such as when musicians sing the wrong notes or mess up a riff. Even when possibilities of failures are technologically mediated, such as when musicians trigger the wrong clips at the wrong time, these possibilities are, for the most part, under the musicians' real-time corporeal control. In other words, these possibilities of musical failures are contingent upon corporeal failures. The risks only turn into failures when musicians mess up with their own hands and bodies.

By contrast, for real-time algorithmic techniques, the possibilities of failures are speculative and indeterminate. They are always possible, but we are never certain when and how they will manifest. When performing with these techniques on the live stage, there is no turning back, redoing, or monitoring *then* applying. The musician and their computer only have a single try to attempt the function. Given the indeterminate nature of algorithmic processes, one can very well anticipate that the processes of calculation and calibration may not unfold as intended. Situating in live contexts, algorithmic configurations further calcify the impossibility of a determinate and grounded musicianship. As Louise Amoore (2020) put it, "the bifurcated 'forks' in the algorithm's calculative architecture . . . involve a profound uncertainty of authorship and its future effects" (p. 88).

Below, I use two scenarios—live looping and live coding—to illustrate how musicians usher in new conceptions of liveness and musical authenticity as they embrace the speculative possibilities of failures against the ontological property of uncertainty inherent to the real-time operations of these algorithmic techniques. This embracement of algorithmic failures is most evident in the traditions of noise music

(Cascone, 2017; Kelly, 2009; Klett & Gerber, 2014). Yet I argue this is not a genre-specific propensity—but a quality that is ontologically linked to the *techniques* of real-time algorithmic configurations.

Live Looping With Quantization

Live looping is the practice where musicians record a piece of music in real time for immediate playback on stage. To enhance the accuracy of live looping, digital audio interfaces—often by design and default—incorporate techniques of quantization to adjust the notes in a live loop. Quantization is the process that transforms performed musical notes, which may have some imprecision due to expressive performance, to an underlying musical representation that eliminates the imprecision. Quantization functions against the backdrop of classical music theory as the rules for their procedures. Oftentimes, quantization is used for pitch correction, or to resituate notes on particular fractions of beats.

While quantization may be designed for precision's sake, when used for live looping, the technique introduces an inextricable sense of uncertainty. For instance, the computer may misinterpret an expressive rhythmic fluctuation as imprecise, thereby removing such expressivity in ways unanticipated by the musician. As another example, the musician might miss (or mess up) a note when they attempt to record for live looping, or the computer might fail to register a note in the process. In these scenarios, quantization may reorder the loop recording in bizarre and surprising ways, as the way the expression is computationally recognized may differ from the musician's initial guesswork. As a result, the loop may play out in ways that are unintended by the musicians. And since this is a *live* loop, the musician will only know the outcome of quantization at the same time as their audiences. By nature of their real-time operations, there are no options for previews or re-recording.

Live Coding with Stochastic Randomness

Beyond the indeterminacy inherent to real-time algorithmic techniques, musicians may also embrace an additional layer of uncertainty by welcoming *stochastic randomness*. This is most evident in the tradition of live coding (Armitage & Thornham, 2021; Briones, 2022; Cocker, 2016, 2018). Live coding is the practice of improvising sonic, visual, and multimedia experiences using code in real time. At live coding events,

> code is projected onto a screen behind the live coder, who "writes" on their laptop through a range of software. The code "generates" sounds and beats, music and rhythm, and the live coder "builds" music in front of a live audience. (Armitage & Thornham, 2021, p. 91)

Oftentimes, live coders may recall stochastic functions that will produce sonic expressions in ways that are arbitrary, surprising, and unexpected. Such processes unfold randomly and do not follow any a priori rules. In this case, the live coders hone in on the stochastic nature of these algorithmic processes to not only welcome indeterminacy—but center it as a key tenet of their expressivity. Right in front of their audiences, these live coders are "thinking in action" (Cocker, 2016, p. 102) as the sound is building, evolving—and failing—across the timescape of stochastic randomness.

Shared Understandings of Uncertainty

In the cases of both live looping and live coding, the possibilities of failures are not merely welcomed by the musicians as their personal aesthetic choices. Rather, this embracing of failures is *cultural*––established as shared expectations between the musicians and their audiences. While the audiences may not understand the underlying mechanisms that contribute to the failures of live looping and live coding, what they do, however, is acknowledge that such failures are probable; they designate such possibilities as the baseline against which they set their expectations for the thrill of liveness. It is only against the public expectations of failures––that algorithmic processes can always go wrong when performing live––that musicians are able to enact spectacles of suspense by playfully engaging with the inherent uncertainty of algorithms.

Anticipating and Preparing for Failures: Rethinking the Ethics of Algorithms

By zooming in on techniques of real-time algorithmic configurations on the live music stage, this article foregrounds how the possibilities of their failures are always already here given the ontological uncertainty of algorithmic processes in the contexts of real-time operations. Building on Mike Ananny's (2016) and Daniel Susser's (2022) temporal perspectives on the ethics of algorithms, I thus call for a reorientation toward an ethics of algorithms that anticipate and prepare for failures *to come*. If we think of our world as a never-ending live stage permeated by real-time algorithmic processes, then we must prepare for failures are probable scenarios we will encounter at one point or another. Popular approaches to governing algorithms often strive to make them error-free through preemptive measures, such as adversarial testing, audits, and benchmarking. Yet the contexts of real-time operations foreground the impossibility of eliminating algorithmic errors once and for all through such preemptive measures.

Instead of clinging to the ideal of a perfect(ed) algorithm as the end-all-be-all (Lin & Jackson, 2023), an ethics of algorithms that attend to their real-timeness must instead turn to fosterg shared expectations of—and preparations for—the occurrences of failures. Establishing shared expectations of failures is critical to holding them accountable as *public* concerns (Ananny, 2024). For musicians, they are able to enact their authenticity on the live stage on the grounds of the expectations they share with their audiences—that the algorithmic techniques they use are inherently indeterminate and that their failures are always probable in real-time operations. Instead of brushing off failures as surprises, a pragmatist orientation to the ethics of algorithms may instead call for rethinking *how* we want to engage with failures knowing that they are always probable. The shared expectations of algorithmic failures in live music culture may serve as a blueprint, but it could also look radically different in different contexts.

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