

# *Musicians (Don't) Play Algorithms. Or: What makes a musical performance*



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## *Abstract*

Our private perception of listening to an individualized playlist during a jog is very different from the interaction we might experience at a live concert. We do realize that music is not necessarily a performing art, such as dancing or theater, while our demands regarding musical performances are conflicting: We expect perfect sound quality and the thrill of the immediate. We want the artist to overwhelm us with her virtuosity and we want her to struggle, just like a human. We want to engage with the musical expression and rely on visual and physical cues. Considering that the ears of today's listeners are used to technologically mediated music, in this paper I explore the unique qualities of musical live performances and examine if our conception allows for new mechatronic inventions, in particular robotic musicians, to participate in this art form. Some of Godlovitch's main thoughts expounded in his work on "musical performance" [11] serve as a reference and starting point for this investigation. His concept of 'personalism', which deprives computer-/program-based musical performances from expressive potential and creative accomplishment is an issue that I want to challenge by pointing out new approaches arising from a reflective discourse on technology, embodiment and expression. The enquiry conducted illustrates, how in reasoning about machine performers and algorithmic realization of music, we also examine the perceptual, physical and social aspects of human musicianship, reconceptualizing our understanding of a musical live performance.

**Keywords:** *embodiment, expression, music, performance, robotic musicianship, technology*

## *1 Introduction: Where the music happens*

Even though the music we listen to/consume regularly is recorded<sup>1</sup> – and we listen to it in different settings; on the subway through cheap

headphones or at home with a potent Hi-Fi system – we still enjoy live concerts. Not seldom artists perform in fully booked football stadiums. It is obvious that what we are getting there differs in many ways from the experience of merely listening to a record, and so are our motivations to attend a live act. Usually we go there for the performer. We go there expecting something special and unique, since there can be no replica of a live performance. We expect the “aura”<sup>2</sup> of the immediate and the possibility of interaction. With our ears being used to studio-records and the standardized effects (e.g. balancing, layering, tuning) of technologically mediated music, however, a gap emerges between the habitual and the actual. In fact, as Black [4, p. 34] points out, this discrepancy is irreconcilable, since,

*[a]fter the movement away from realistic acoustics in popular music and the rise of multi-track recording (which breaks performances down into component parts which no longer need to originate at the same place and time), today most songs canonically exist as recorded artefacts which often cannot possibly be reproduced through live performance.*

So the sound of recorded and live performed music does not necessarily have to be the same, and as argued, cannot be the same in most cases, even though live music and technologically mediated music are imitating each other [10, p. 199]. Hence, in our regular consumption of music, we have to acknowledge the fact that we are never just listening to the artist, but also to the sound engineer (as an off-stage representative). Technology has changed our perception of what is live. However, we should not underestimate the audience’s awareness towards music as an art form, with artistic concepts and the distinctive features of live performance strongly determining the sound. Thus, our expectations regarding musical live performance may vary: If you listen to cloud rap and then go to see Yung Hurn “live”, you are aware that his live vocals will only be a marginal part of the performance. Then again, when you buy a ticket to hear Patti Smith, you want it to be “real and raw”. It goes to show that we generally expect an artistic concept to remain the same – on a record as well as at a concert –, although different types of musical performance possess different idiosyncratic sound qualities that are influenced by technology to a greater or lesser extent, which clearly affects the acoustic realization or reproducibility of music in a live setting.

Let’s take another step and presume that the presentation of music goes further than sound, by being expressive and performative. But

what makes it those things? The first intuition tells us that it has to do with the artist behind the sound: while observing her on-stage, we are getting involved as she might communicate an idea or a feeling through her interpretation of the music she makes. If we follow the Romantic-era understanding of aesthetics, which strongly aligns with the popular view, this intuition draws upon the motif of a ‘transitive experience’ of musical expression: an emotional communication from performer to listener [2, p. 84]. Ideally, in case of communicative success, we are moved by her expression and we get to understand something about the musical piece. Under this conception, both the performance of and listening to music constitute creative acts and require emotional competency from the agents (composers/performers on and off-stage/listeners) involved. I want to point out that the listener, beyond the musical piece, might also understand something about the artist, however, the emotions expressed in or by a musical piece do not necessarily have to refer to an actual emotional state (past or present), of any of the agents involved. A musical piece *is expressive of* emotions<sup>3</sup>, independently of a felt emotion of the performer during the performance. At the same time, the capability of experiencing the emotions that a piece may be expressive of, seems to be preconditioned somehow: Taking the audience’s perspective, even if the performer doesn’t have to be sad during the live performance of a song that is expressive of sadness, we typically expect her to know that emotion and to be capable of feeling it in a given real-life situation.

Now, this expectation needs reconsidering when taking into account the musical performance of technologically produced music. For when we feel that technologically produced music or the mechanical performance of music may still strike and move us, the question arises whether we can still call it a transitive experience? This question may touch upon genres of electronic music, but more obviously concerns the music produced by robotic instruments as automated mechanical constructions (like Fourneaux’s player piano ‘Pianista’ from 1863) and robotic musicians<sup>4</sup>. Today, we find these equipped with a “combination of musical, perceptual, and interaction skills with the capacity to produce rich acoustic responses in a physical and visual manner” [24, p. 28]. Even though one cannot deny that, somehow, and at some point, humans are somewhere behind the sounds produced by a machine, when machines are producing music, humans are not physically making it themselves. There is a machine at work; however when we as listeners experience that the acoustic result of the machine does something to us, i.e. moves us, would we say that the machine has communicated an emotion to us?

Given that it cannot feel emotions, it seems clear that it cannot communicate *its* emotion, but can it, if it is not capable of feeling, communicate the emotion of a musical piece to us? One answer to this is: Yes, even when there is no emotion being transmitted, and we cannot make out a connection between the ‘origin’ and the work of art, we, as listeners might generate meaning through the ‘embodiment’ of sensory stimuli implied in musical action. Embodied cognition, playing an increasingly important role in AI-research – most notably due to works of Brooks [see e.g. 6] – since 1980 and also re-opening the philosophical debate on body and mind advocates the following thesis:

*Many features of cognition are embodied in that they are deeply dependent upon characteristics of the physical body of an agent, such that the agent’s beyond-the-brain body plays a significant causal role, or a physically constitutive role, in that agent’s cognitive processing.* [26, chpt. 3]

If we accept that having a body with sensorimotor capacities is fundamentally determining how we, as agents experience things/situations and that all our cognitive processing therefore is inevitable shaped by those experiences, then musical performance may serve as an illustrative example: There is no question that our perception of and reaction to musical performance is “deeply dependent upon the characteristics of (our) physical body” [26, chpt. 3] – we hear it (neuroscience states that music only becomes music “inside of us”, for sounds, as ‘secondary qualities’ along with color or smell, are not in the world around us), we feel it (resonating), we move to it (dancing, or however you want to call your rhythmical implementation); these are our ‘tools’ to generate meaning based on the given stimuli. To put it simply: We experience music the way we do, precisely because we are “put together” the way we are<sup>5</sup>. To conceptualize this type of experience, one may take over an ‘intransitive perspective’ [2, p. 85], which opens up a territory for technologically generated music and robotic instruments or robotic musicians within which to become expressive<sup>6</sup>.

*The understanding of gesture and embodiment as the pathway for intransitive expressive communication suggests that listeners create meaning by embodying both visual-sonic and purely sonic gestures. In this view, listeners create musical meaning based on their interpretation and embodiment of sensory stimuli.* [2, p. 85]

As long as the computer is equipped with channels of communication (e.g. visual-sonic gestures for the given purpose, but also through a voice or images on a screen), action and perception go hand in hand. Picard argues, that such channels allow for computers to express emotions, even though they themselves do not possess them [19, p. 3].

It is now relevant to highlight some differences within the performance of technologically generated music, which I will explain in reference to the live performance of electronic music, automats like player pianos, and robotic musicians. Firstly, when it comes to electronic music, in many cases its live performance is generated by a DJ, who acts on the basis of an existing pool of musical information, adding her physical presence and technical skills to the performance. For an audience, the artistic human body on stage facilitates the traceability of the acoustic result and visualizes musical embodiment. Player pianos and other automats by contrast, lack the perceivable physical presence of the performing artist, as they are playing “themselves” from “within”. This absence makes it hard for us to acknowledge the live performance as such, even if we, the audience are aware of the algorithm at work and can therefore deduce what creates the sound (just like we know the wind harp is not playing by itself) – something seems to be missing.

So far, our expectations of a musical live performance (section 2 will examine conceptions of ‘performance’ more closely) can roughly be summarized as follows: a unique experience of acoustic signals as musical expression produced by a ‘performing body’, which is physically perceivable and allows for interaction; in many cases we also have certain expectations regarding the artistic concept or musical genre based on our prior experiences and knowledge. Why not already put forward the question, whether robotic musicians are able to meet these expectations and collect some pertinent features: Robotic musicians are producing sounds in a perceivable way (the mechanical apparatus converts digital musical instructions into physically generated acoustic sound; [24, p. 28]). They combine algorithmic analysis and response capabilities (which we typically associate with human artists). These qualities allow them to interact with other musicians on stage<sup>7</sup> and accentuate the musical expression, over gestural channels as sonic nuances, i.e. articulation, timbre, dynamics, phrasing and visual aspects, with certain degrees of freedom for dynamic physical behavior, such as rhythmical body movement<sup>8</sup>. Though tentative yet, this quick analysis of the differences between human live performance and technologically produced music and those within the latter suggests that viewed from an intransitive per-

spective, the live performance of the robotic musicians seems to endorse the potential of such machines to convey and inspire the expression of emotions contained by a musical piece [2, p. 86].

Whether one accepts this point of view is clearly also dependent on a crucial question of demarcation: when we conceptualize a musical production of a robot, do we see the robot *playing* the instrument or is it rather that the robot and the sound-emitting body form *one* instrument? Typically, robotic musicians are designed to perform on one particular instrument, i.e. they are designed for this one specific symbiosis. This means that if we take apart the instrument and robot, formerly constituting one instrument, and let's say replace the marimba with a flute, the robot would no longer be able to perform. Now if we take away the marimba from a human artist and replace it with another instrument, the human musician may equally fail to adapt and to achieve the desired acoustic results immediately, but in most cases we can expect her to be physically and cognitively capable of producing some sounds intuitively. Following the unique, or even ontological symbiosis of the robot with its instrument, it remains debatable whether we can talk of a performing body in the case of the robotic musician.

## **2 *Playing it. Concepts of performance, technology and creativity***

This section is meant to reflect on the key terms my investigation is drawing upon, with the aim to challenge dominant views and experiment with new perspectives. There are various concepts of performance. Relevant for the issues discussed in this paper are those, which concentrate on performance in performing arts, usually consisting of the following elements: time, space, the performer's body and a relationship between audience and performer, plus the artistic content, whereby content, time and space form a unity. Godlovitch's idealized model of musical performance draws upon the theme of *techne*, presenting performance as an "agent-centered intentional enterprise which invokes special skills to create musical experiences for attentive listeners" [11, p. 4]. He also addresses the spatiotemporal aspect in the description of a "highly intricate event comprising players, sounds, works and listeners in a ritual setting" [11, p. 1]. Building on this model and accommodating it to new forms of technologically mediated musical performances, Black emphasizes the "qualities of the person or persons producing music in the context of performance" [4, p. 35], and adds as an extending aspect

“some kind of ongoing, real-time feedback loop controlled by the body of the performer” [4, p. 47]. Following this view, a skilled DJ, just like a singer using *Autotune* at a live concert, would make ‘a performance’. A machine that is just producing programmed sounds, however, would not fall under this definition. An interactive robotic musician on the other hand could, although we have to be aware of the fact that the robot is not improvising the algorithms but improvising *on* algorithms<sup>9</sup> (a fact I will address in more detail at the end of section 3).

I am now taking up Godlovitch’s reference to *techne* and bringing technology (and technological innovation) into play, having its etymological roots in the very term, which is generally understood as materialized logos, intended by a human. The meaning can be expanded though, and for the given context I want to refer to a notion, illustrated by Coeckelbergh [8, p. 504f.], interpreting *techne* as a kind of *poiesis* (bringing into being; the prevalent understanding of the term as the cause that brings non-existing into existing also takes all forms of art as arising from it). He draws on Heidegger, who argues that the connection of the concepts (*techne and poiesis*) lies in the drive of bringing-forth, and that this process is to be located not in itself (like the physical drive of bringing-forth), but in another – the craftsman or artist [13]. Technological innovations and art both become part of this concept. Coeckelbergh points out that this conception amends the role of the human as creator: he becomes a mere participant in the ‘performative process’ (for a further understanding of the term see below).

*The work of art or the artefact is not exclusively the result of human intention, it also involves – so we may interpret Heidegger – the “participation” of the material. There is a process of making and revealing in which both humans and non-humans take part.* [8, p. 505]

This idea makes us question the common view of art and technological innovations as concepts that get realized through material only due to the artists/creators/masters will and intention. I want to instance a practical thought regarding musical performance that might not do justice to the complexity of the concepts sketched above, however I still consider it helpful: The (musical and technological) tools (as ‘material’) involved are participating in the performance, as in the end it is them, who are causing the sounds we perceive. There is no musical performance without additional tools (one might respond: “What about a cappella singing?”), but even there, a tuning fork or microphones might be at use) and the performing artist has to learn how to react to the tools and

work *with them* (this also counts for singers which have to work with [the physical attributes of] their voices). They may get out of tune, because of temperature changes or a string may snap, because it was pulled too hard, there may be acoustic feedback (ringing noise) from a (monitor) speaker on stage, because the output of the speaker was picked up by the microphone, creating a positive loop gain – whatever the struggles or circumstances: the tools may cooperate or not.

Coming from this perspective it is easy to see that there are no mere passive tools in musical performance; but reflecting on our traditional concept of human musicianship, this is not what we're believing in. We are talking of "mastering the guitar" or "slaying a tune" and thus seem far from awarding them agency. Robotic musicians may serve as a bridge that refines our perception of tools and artists in a musical performance, as they merge elements of what we perceive as "passive" and "active". Once we understand that the human artist herself is working/playing with algorithms (compositions, scores) and inevitably cooperating with the material, we may allow technological innovations to participate in the 'sacred domain' of music (and music as performing art)<sup>10</sup>. The idea of the technological innovation as an active element in artistic or scientific work processes roots in the revolutionary peak of the Romantic era (1820–1850). Tresch depicts "the romantic machine" in his eponymous book [22] as "flexible, active, and inextricably woven into circuits of both living and inanimate elements" [22, xi], accompanying new, and later neglected understandings of nature ("as growing, complexly interdependent, and modifiable" [22, xi]) and knowledge ("as an active, transformative intervention in which human thoughts, feelings, and intention – in short, human consciousness – played an inevitable role in establishing truth" [22, xi]). Now I do not ask you to go back in time and reanimate these conceptions; what I am suggestion though – with help of the theories outlined above – is a reflection on the function, role and (revelatory) potential of tools in artistic processes, such as musical performance.

In this regard the following critical question may be raised: "How do the performing bodies (including tools) on stage and the work of art connect?" This is an important question, as it is examining what the artist's contribution to the performance actually consists in. Is she representative for the 'space', where the creative impulse for the workings of art is located? Is she proofing that the performance does not consist in mere sound?

I want to introduce the term 'performative process', as it illustrates



that reducing performance to the mere presentation of an artwork (outcome) falls short. The term comprises the preparation (process of creation) as well as the action (making and revealing) in the given setting and the participation/reaction of the audience in the moment of the presentation. This is important, for the separation of the two aspects ‘process’ and ‘product’ does not make sense if we take the status of the product to be constituted by the process and that in the end the process is judged by its product. Coeckelbergh further elaborates this thought within the context of subjective and objective criteria for a work of art and, just as I do in this paper, draws upon the new presence of technological inventions in arts to assess what these criteria may be [7, p. 295]. As he explains, a machine might perform a musical work, but we cannot foretell how the audience will react to it and whether the audience will recognize the produced music as art. This applies to artistic machines as well as aspiring human artists. So whenever there is a performative process, one may say, art might emerge from it, or not [7, p. 295]. This view is cogent, especially in the context of live music. Let us think of the following, for example: Whether you listen to a recording or an orchestral live performance of Bach’s “Matthäus-Passion”, it is rather unlikely that you will question the artistic value of the work you are confronted with. But let us say you discover a new artist because YouTube suggested a taste-customized video based on your previous listenings, then you might attend a concert to verify if she succeeds to fulfill your expectations also in that context. If her live performance convinces you, then you might say “Yes, her music has artistic value”.

Godlovitch’s imaginary piano competition scene [11, chpt. 6] describes how a panel of blindfolded judges, unaware of the fact that all participants are computer programs driving conventional pianos and impressed by the level of talent, choose player #8 as the winner. As they find out who (what) was performing, they are shocked and call it a mistrial. There are two questions Godlovitch raises: i) “Are we witness to a musical performance here?” and ii) “Have such eventualities hope of full standing in our musical culture or are they artistically aberrant?” [11, p. 125]; and I want to pursue these questions in a moment (section 3). Yet before, I would like to emphasize that what the judges are confronted with is pure outcome. They have no knowledge of the ‘creative process’, i.e. the internal workings of the program. However, that is a fundamental part, when it comes to artistic creativity. The same counts for computational creativity. What the Turing test shows, is how an outcome is not necessarily representative of an original artistic

idea. It is also completely disconnected from the creator and intentionally we would say that that feels wrong. Even if we want to question the dictating role of the creator – she still remains a participant in the process.

So it seems that it is in the process of creation, where we want to find meaning – meaning we put to use for understanding the output and being able to judge it. With regard to artistic creation, two prevalent views are confronting each other: self-expression (romantic) of something inner, and mimesis (antiquity), the imitation of something outside. We can see that there are parallels between the former view and the transitive perspective concerning musical (artistic) expression. Both exclude machines a priori from the artistic processes. There might be a chance for machine musicianship to become a part of performative art within the theories of mimesis and the intransitive perspective, if we acknowledge these views as valid. What mimesis should not mean in this context though, is imitation of human artistic creation by machines<sup>11</sup>. A player piano that imitates Glenn Gould's Bach-interpretations does not satisfy the idea<sup>12</sup>. Godlovitch's imaginary participants may fail many of the claims that would make a musical performance (now we come back to his questions, see above): they lack a body (when the winner is called, it gets respectfully laid on a disc-stand), their action and reaction is spatiotemporally detached from the process of creation and what they present to us is pure output<sup>13</sup>. Then again, we might generate meaning from the musical piece (intransitively), and we might acknowledge the process of creation, once we get to know how the program "plays the algorithm".

### ***3 The making of an artist. On personalism, artistic agency, and being (creatively) expressive***

Godlovitch seeks to find an answer to his questions concerning artistic agency and merit in musical performances (see above) in the matter of 'witnessing' and puts the ball back in the judges' court (the decision-making panel as in the piano competition sketched above; I assume that in the context of a traditional concert not only the domain experts, but the common audience is entitled to judge, whether or not they are witnessing a musical performance). Just like in boxing matches, it is the judges' responsibility to recognize fouls, withdraw points, and honor the skilled. The metaphor connotes primarily technical skills and Godlovitch seems to realize that this is not really doing justice to artistic perfor-

mance. What he introduces then, is the concept of the ‘personalist’, who anticipates “the individualistic in performance, the person-centered particularities of performance and manner” [11, p. 141]. It should remind us that the main reason why we even attend a concert is the person on stage. We observe her, fallible like us, exposing her unique qualities. Noë goes even further than that, arguing that in all genres of popular music it is the artistic person we are interested in; here the music serves mainly as a medium to act out a specific image (embedding social, cultural, and political aspects) [18, chpt. 15]. That way the artist is putting “us” on display, as a representative for a certain life-style at a certain time and place; her musical practice is influenced by and looping back to the living practice of the audience.

Now, Godlovitch, who is describing his program-players in an uncanny-theme as “endowed with an otherworldly essence” [11, p. 140] concludes that artistic merit is not possible, if nothing whatever “inside” [11, p. 140] the artist counts. Let me make a remark here: It seems difficult to grasp, what the “inside” exactly consists in – in a personal story of human life, in emotions, in social, cultural, political imprints? Additionally, as pointed out above, artistic creation is not necessarily bound to self-expression of something “inner”, but can manifest through the imitation of something “outside”. Levinson’s ‘persona theory’ [16] offers an instructive approach to this issue. The core idea is the following: if we acknowledge the fact, that a musical piece itself (or the performing artist, when it comes to machines) does not possess any emotions (although it can be *expressive of* emotions), we may experience the performance of music as the expression of a fictional musical agent or ‘persona’ that is completely independent of the performer. This is interesting for our question concerning person-centered artistic merit out of multiple reasons. Firstly, it makes the attachment of human emotions to objects, such as a musical piece, appear less disconcerting. Secondly, it also explains, how the performance of an artistic group (an orchestra, a band) may generate one unique expression that does not depend on the individual performing components, but rather on (the story of) a fictional agent. And thirdly, this view invites non-human performers to create music that is able to be expressive of anything that a fictional agent may experience. All of this obviously depends on the imagination of the willing listener, who is ready to engage with this understanding of musical expression. A competent listener, who does not *need* this “trick” of imaginative engagement in order to generate meaning for a musical piece might criticize this view, as Davies argues [cf. 9, p. 189].

Robinson expands Levinson's ideas, as she argues that particularly music in the Western tradition evokes a persona-oriented listening. She further adds that some aesthetic concepts, such as Romanticism, do claim that the artist is actually experiencing or at least engaging with the emotions being expressed [20, p. 325]. In these cases, we cannot differentiate between a fictional persona and the performer (or composer). When it comes to the value of expressive music, Robinson argues that we typically appreciate art, which allows us to pseudo-experience an emotion [20, p. 290] – art as a sort of playground, so to say (these are not the author's exact words, rather my pointed view on it). I want to provide some examples to illustrate this idea: When you attend an underground punk concert, you may engage with rebellion or anger in a ritualized setting. Listening to Rammstein (a German rock band, founded in 1994 which is often associated with the genre of "Neue Deutsche Härte") allows you to experiment with the feeling of hatred or what it is like to enjoy BDSM; while listening to Chopin's Prelude in A Minor (Op. 28, No. 2) might give you a taste of Weltschmerz.

At this point, I want to take a step back to the agent-oriented understandings of performance and refer to the concept of agency as the capability of individuals to have an original impact on the world. If we understand action as the expression of identity (or individuality?), we also create a link to Godlovitch's claim of personalism. My (Arendtian) understanding of action includes the attributes that action cannot be predetermined and that it leaves space for variability and interaction. We can differentiate action (from fabrication), because the act happens in the here and now, which implies physical presence and immediateness, mirroring the particularities of a live performance. A strict interpretation of this thought excludes technology from agency, because in technology the action is not resulting from intentionality but from an algorithm. From a phenomenological perspective it seems essential that the audience experiences a musical performance as spatiotemporally immediate, i.e. arising on-site before their ears and eyes. Harper uses the term *jouissance* (as the combination of action, iteration and aura) in order to describe the pleasure that only live music evokes in us [12]. So let us say that the here and now are uncontestable factors for creating this kind of pleasure and investigate what 'expression within action' can mean from this point of view.

*Public behaviour is just the natural cue for beliefs about the performer's circumstances and inner states which both cause and are occasioned by the music created in performance. Our*

*unhesitant positing of these inner states affects our views of the expressive richness of the performance or the structural clarity of the technique.* [11, p. 141]

What I particularly want to highlight in this quote is the link that we seem to create between the visually and acoustically perceivable expression of performance and quality designations, such as “structural clarity of technique”. This is important in regards of robotic musicianship, for all forms of program-based musical robotics are known to be capable of performing technically difficult sequences flawlessly while lacking the kind of expressive uniqueness that is typically associated with human musicians who develop their own – often recognizable – style and sound (think of Glenn Gould again). We do know that every instrument theoretically sounds different with every performer playing it. This is primarily due to laws of physics (e.g. physical attributes such as lung volume, resonance body, qualities of skin and flesh, proportions, but also finger technique or embouchure). However, that sound information is not enough to make out the artist (and her unique style) “behind it”. Nuances, such as steering articulation, timbre, dynamics and phrasing are pivotal when it comes to rendering a piece of music creatively expressive. Imagine a pianist interpreting a challenging piece (e.g. a piano concerto by Prokofiev), and try to picture her without any sound – I take it that you are visualizing a moving body, accentuating different themes and dynamics. A study [23] from UCL professor (and classical pianist) Tsay shows that we even go as far as taking the visually perceivable interpretative physical behavior as a proof for artistic quality prior to the actual sound of a performance. So it seems that even if we understand musical performance from a perspective that allows intransitive expression of something outside, we still need visual feedback connecting to the sound, to proof that there is a creative act happening before our ears and eyes.

Godlovitch questions, if it were reasonable to request performing machines to be creatively expressive in this way (“Is this excessive?” [11, p. 128]). 20 years after Godlovitch’s publication designers of robotic musicians like Weinberg or Barton are and have been working exactly on that aspect. This field of research describes the expressive capabilities of mechatronic instruments in terms of “the number of controllable sonic parameters as well as the resolution of these parameters” [2, p. 85]. Bretan, Hoffman and Weinberg are also investigating the “emotionally expressive dynamic physical behaviors in robots”, as they have been creating an “artificial emotional intelligence system, for robots, with both a

generative and a perceptual aspect” [5, p. 1], by using music as a means to engage participants and encourage them to dance (in an interactive experience). “Shimi” for example is an interactive speaker-doc, possessing five degrees of freedom that allow certain postures and dynamic gestures to represent fundamental human emotions<sup>14</sup>. Although “Shimi” does not have a face, it is expressive through motion. The researchers build upon recent studies of musical gesture that show how musical expression can manifest through the embodied experience of the auditor [2, p. 85]. This liberates robotic music from the necessity to mimic human performers, opening up a different path of expression: the exploration of their, i.e. the robots’, own creative goals, which are unattainable for human artists (e.g. improvisational algorithms, speed and timbre control). Collaborations with robotic instruments (such as Scott Barton’s human-playable robotic “Cyther”) and human-robot joint improvisations (jamming with Weinberg’s et al. percussionist “Haile” or marimba player “Shimon”, see below) are combining these computational and mechanic capabilities with the qualities of human musicianship; whereby the human and the machine musicians are learning from one other. In 2009, Weinberg as lead researcher of The Robotic Musicianship Group at Georgia Tech’s Center for Music Technology introduced their four-armed robotic marimba player “Shimon”, who is able to react to music, improvise, and play along with human musicians. In addition to that, he provides the visual and physical cues we seem to depend upon in our engagement with and judgement of musical performance via dynamic physical behavior (rhythmical head nodding, leaning in at difficult parts, “looking at” ensemble members when finding a common groove). Having watched it myself, I have to admit that their performance is indeed inspiring<sup>15</sup> and it becomes difficult to deny these elaborate machines their expressive potential. So I may say, our conception of musical performance expands, when watching and experiencing a robotic musician’s live performance; this way it is also putting on display and reorganizing our understanding of human musicianship.

I will try to roughly sketch how the real-time improvisational algorithms work, referring to Weinberg’s et al. work on “A Real-Time Genetic Algorithm in Human-Robot Musical Improvisation” [25]. Here, the robot (“Haile” and “Shimon” are two representatives) is equipped with perceptual tools that enable to listen to and analyze MIDI and audio input from human players. It is also equipped with pre-stored human-generated musical phrases that serve to be compared to the new information and evolve through mutation and crossover functions. The

improvisational algorithm is creating fitting responses to the live input in real-time, by fragmenting the latter into short phrases and combining it with the internalized knowledge of relevant material [25, pp. 351-353]. These responses allow human musicians to actually interact with the robotic musician in a live performance, while both parties are challenged in, what I would call their improvisational routine. Two robotic musicians improvising with each other would just build upon modulations of pre-stored phrases, while human musicians also tend to getting caught up in improvisational patterns or conventions. The differences between the performers, as Rowe shows, mean “that the human also acquires a new degree of freedom in invoking and directing real-time algorithms through different styles of performance” [21, p. 7]. The classic call-and-response dynamics may additionally be challenged by a feature that allows the robot to occasionally interrupt or ignore the human musician [25, p. 356]. The question is: How far does it go? I find the aspect of risking musical breaks (irritations) or failure in a musical performance highly interesting and I want to pursue this issue in the last section of this paper. Failure in the given context might imply physical, technical or sonic, as well as interpretative or expressive limitations.

#### *4 Sweat and tears: struggles and empathy*

When we just listen to (recorded) music, we primarily seek an elaborated sound experience. If we are able to observe the artist during the performance of her music though, her body (her sweat, her exertion), her reactions, her interactions, her facial expressions – we realize that she is human just like us, and on this grounds we appreciate her effort even more. We know that she could fail, but she is risking it and we feel for her. Although human and machine artists both aim for flawless performance, and therefore create the risk of failing at it, we do not really expect the machine to fail, at least not technically. We rather expect that it was designed to perform in a certain way (which would also entail that we neither expect it to surprise us in a positive sense) and that is what constitutes a big difference in the live-setting. We do not expect a machine to be nervous, to sweat, be exhausted or struggle. I assume that that bores us. Maybe this has also to do with the malicious joy we experience, when witnessing a successful person’s (professional or private) failure; a phenomenon that is known to be called “Schadenfreude” in German. Normally we do not want an artist to fail – we may even keep our fingers crossed for them or sympathize with

their nervousness – but just the thought that they are not save from it is reconciling. Now, if we were to witness a robotic musician reaching its limits (physically struggling to hit a note, keeping up with the rhythm, or failing to respond in an improvisational setting), would we react empathetic? Would we say: “Wow, it’s giving its all. I can feel its struggle. That’s touching.”? This question reminds me of a passage in E.T.A. Hoffmann’s dark romantic *Kunstmärchen* “Der Sandmann” (published in 1816, here cited as [14]) that depicts the protagonist Nathanael following an invitation from physics professor Spalanzani, who introduces his “daughter” Olimpia, a beautiful automaton, into society. Olimpia performs for the guests, playing the grand piano and singing an aria di bravura with an almost piercingly clear voice. Nathanael, standing in the background, is intrigued by Olimpia’s appearance and observes her through a spotting scope that he bought from Coppola (a trader in barometers and lenses and dubious *doppelgänger* of Coppelius, the alchemist who Nathanael holds responsible for his father’s death). Before Nathanael’s eyes Olimpia becomes increasingly vivid, and he perceives the artificial traces in her performance (blaring trill, factitious roulade) as deep emotional expressions. As he starts to dance with her, he is surprised by her cold surface and her demanding rhythmic rigidity. He also starts to notice that everybody else in the room acts very suspicious towards Olimpia – they are estranged by her eerie spiritless look and feel. Because they are threatened by the uncanniness, they are more than happy to detect flaws in the performing machine and laugh about them. Also Nathanael is obviously deluded in his perception, as he wants Olimpia to be perfect. But what if we didn’t expect a machine to perform flawlessly; what if we allowed it to reach its limits? Would it gain in artistic credibility?

Whether or not mimicked or staged struggle would be effective or convincing for us as an audience to appreciate a robotic musician’s performative effort is another question. We may assume that researchers studying robots are very aware of the fact that we perceive certain imperfections as human traits, but as it is, robotic instruments naturally possess their own idiosyncrasies and limitations (such as micro-variation in timing caused by physical forces, [2, p. 86]). Such imperfections bring to mind that there is actually an effort behind the machines’ performance, and that can be evocative for an audience. However, we would have to be able to witness the struggle, to perceive it in an immediate physical expression. Then we might empathize as we do with the human artist. By shifting our focus from the detection of flaws in the construct



to the actual musical expression, we also start to fully allow it to touch us and make it – with our contribution – a musical performance.

## 5 *Conclusion*

In this paper I examined unique qualities of musical live performances and questioned whether our conception allows for new mechatronic inventions, in particular robotic musicians to participate in this art form. I started with ideas on the key terms performance (comparison of the transitive and intransitive perspective), technology (the creator as participant in the performative process) and creativity (expression of something inner and imitation of something outside) and reflected the role of the artist within these frameworks. Godlovitch's imaginary piano contest served to illustrate what player programs might lack: a body, spatiotemporal immediacy of action and reaction, and the connection between the process of creation and the output. Further questions concerned the person-centered qualities of the performance, artistic agency and expressivity. It became apparent that new designs of robotic musicians meet many of the features we ascribe to a human artists (e.g. physical and visual cues that allow expressive musical interaction) and that they do not need to imitate human artists in order to evoke musical expression. The result shows that we should not necessarily ask, whether machines are musicians, but rather how machines are helping us to understand that (the creative expression of) a musical performance is not exclusively created by the performing artist, but constituted by the participation of the tools as well as the audience's perception and reaction. Robotic musicians are putting (perceptual, physical, technical, cultural and social aspects of) human musicianship on display and therefore allow us to reconceptualize our understanding of it.

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## *Notes*

- 1 And these records are ranging in quality from established data-compression formats (e.g. MP3, AAC, Vorbis) as used e.g. for iTunes or Spotify, to the uncompressed CD and the analog phonograph records, with the classic LP vinyl currently seeing a revival amongst the audiophile listeners.
- 2 I am deliberately referencing Benjamin here. A concert as a ritualized performance (“the location of its original use value“ [3, iv]), happening at a certain time and space stands in opposition to the performing artist’s latest record. So yes, only the concert is unique; however, what we learn from Benjamin is: the record has been “designed for reproducibility“ [3, iv]. This thought also implies that mechanical reproduction reverses the (social) function of art (from being based on rituals to being based on politics).
- 3 I thank an anonymous reviewer for the demarcation between “to express” and “to be expressive of”.
- 4 Kapur offers a comprehensive historical review of musical robots [15].
- 5 This sentence is strongly inspired by my reading of Noë [18, cf. p. 185].
- 6 Barton and Kemper are introducing the term of mechatronic expression to “differentiate expressive meaning in performances that include robotic instruments from music performed by humans” [2, p. 85].
- 7 In the past years Barton has been developing the software and hardware system HARMI (Human and Robotic Musical Improvisation) [1] that allows human-robot improvisation; Weinberg et al. have been working on a Real-Time Genetic Algorithm [25] in Human-Robot Musical Improvisation.
- 8 Weinberg’s and Driscoll’s concept of robotic musicianship [24] considers not only the capability of sonic nuance, but the visual aspects of performance as well as our ability to imbue meaning by anthropomorphizing these instruments.
- 9 I thank an anonymous reviewer for making me aware of the importance of this distinction.
- 10 Lewis’s project of the computer music composition “Voyager“ [17] is a revealing work in this context, demonstrating how “notions about the nature and function of music become embedded into the structure of software-based musical systems and compositions“, as “interactions with these systems tend to reveal characteristics of the community of thought and culture that produced them“ [17, p.33].
- 11 Godlovitch differentiates between “simulators“ and “(artist)-adulators“ [11, p. 126f.].
- 12 Regarding the issues in this paper it might be more apt to refer to original compositions only, which make it easier for machines to participate equally. Otherwise “imitation” will always be the first accusation, since we cannot help but compare different interpretations of the same piece (and everyone loses against Gould).

- 13 Although Godlovitch imagines them as sophisticated player programs, each individual, operating autonomously and guaranteeing interpretive diversity, reacting to acoustics and fitted with musical theories and historical data.
- 14 The authors name happiness, sadness, anger, fear, surprise and disgust [5].
- 15 See it yourself: <https://www.shimonrobot.com/>, 10.03.2019

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