Aesthetics, interaction and machine improvisation

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July 12, 2021

Abstract

Departing from the artistic research project Goodbye Intuition (GI) hosted by the Norwegian Academy of Music in Oslo, this article discusses the aesthetics of improvising with machines. Playing with a system such as the one described in this article, with limited intelligence and no real cognitive skills, will obviously reveal the weaknesses of the system, but it will also convey part of the preconditions and aesthetic frameworks that the human improviser brings to the table. If we want the autonomous system to have the same kind of freedom we commonly value in human players' improvisational practice, are we prepared to accept that it may develop in a direction that departs from our original aesthetical ambitions? The analyses is based on some of the documented interplay between the musicians in a group in workshops and laboratories. The question of what constitutes an ethical relationship in this kind of improvisation is briefly discussed. The aspect of embodiment emerges as a central obstacle in the development of musical improvisation with machines.

Introduction

The artistic research project *Goodbye Intuition* (GI), hosted by the Norwegian Academy of Music in Oslo, is a platform to explore the meaning of intuition, musical structure and aesthetics by means of playing with a newly developed improvisation machine, nick-named Kim Auto (KA) (Grydeland and Qvenild 2019). By introducing this fifth member GI attempts to challenge the roles and aesthetical values of the four musicians in the group and explore what kinds of music may emerge from the experiments. The core method is artistic and the members engage in improvisations with the new machine member followed by discussions and reflections, sometimes carried out in the context of open laboratories. The labs are open and the audience is invited to listen and participate in the discussions.

Whether KA is an instrument, a performer, a composer or a composition is difficult to define, but the meaning and significance of these different modalities of musical knowledge and communication has some impact on the relations that are possible

within GI. That there is a dynamic variability concerning the possible roles of the computer in musical applications in interactive music is confirmed by composer Cort Lippe who states that:

> a composer can assign a variety of roles to a computer in an interactive music environment. The computer can be given the role of instrument, performer, conductor, and/or composer. These roles can exist simultaneously and/or change continually, and it is not necessary to conceive of this continuum horizontally. (Lippe 2002: p. 2)

The basic outline of KA is that it collects material from whoever is playing with it and constructs an archive of material that it uses when it performs. It has four different personalities that may be configured and that defines how it responds to input. These are used to shape its output based on musical concepts such as high/low pitch, and structural aspects such as dense or sparse. By interpolating between the different personalities the responsiveness of the system and its output may be varied.

The research questions in GI revolve around the notion of the improviser's identity in the music and whether the presence of a creative machine would alter the way they listen or play. Also included in the inquiry is the more general aesthetic question of what kind of music may emerge from these experiments. The question of whether KA is a *good* co-player in a musical, or artistic sense is primarily investigated from the point of view of the practice of playing with it. Improvising with KA brings forward questions relating to the point of view of both what is expected from it and what is expected from oneself. GI is not a music technology project and does not primarily claim to be innovative on the level of the development of KA,[1] nor is this article a discussion of the underlying technology, except very briefly.

As was mentioned above, the project is set up around a series of internal workshops in which people external to the group are invited to discuss the processes. These include British musician and writer David Toop and myself, and on one occasion the workshop was led by American director and writer Annie Dorsen. We have been part of the discussions and to some extent we also contribute artistically. Worth noting is the fact that the methodology of the project does not list concerts as the main form for output. Instead the work is presented in a laboratory format with the purpose to engage the audience in a discussion concerning the general goal of the project.

The focus for this article is to discuss some of the preliminary results from my study on the interaction in *Goodbye Intuition* and the machine improviser KA with the attempt to identify the aspects of the interplay that triggered discussions concerning aesthetical judgements and the sensation of interactivity. Analysing some of the discussions

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[1] It is NOTAM in Oslo, a centre for the development and innovative use of technology in music and the arts, that does the development of KA rather than the members of the group.

in a few of the laboratories and workshops performed in the project, the music that came out of it, as well as the responses from the participating musicians, sheds some light on the way that value judgements are developed, and sometimes questioned in the group. There is a particular interpretative space that is opened up through the experience of playing with the seemingly responsive[2] machine co-player that is examined within the project and also in this article.

To improvise with a computer running an adaptive software for musical interaction raises questions that have relevance to both the designer of the improvising system and the musicians playing with it. In these cases it is difficult to avoid some level of anthropomorphism among the users (Blackwell and Young 2004; Young 2009), but it is also clear that this effect contributes to the willingness to engage with the system (Nowak and Biocca 2003), and in some cases the ability to learn from it (Schneider et al. 2019). In GI the very fact that the machine is given a personal name points to the willingness to attribute some aspect of human traits to it. While this contributes to the sensation that the machine is intelligent in a human sense (which it is not), it also puts a limitation to what is possible from a system point of view. If it proves to be possible to create a machine system that can improvise interactively and creatively, why restrain the machine to behave like a human? If not, by what standard do we allow ourselves to limit its freedom? Although speculative and abstract in nature, this inquiry leads to a number of questions concerning, for example, machine ethics that I hope to continue to pursue in the near future, but which may also be seen as a backdrop for the present study.

Method and background

Since I have been an active part in many of the workshops and laboratories performed by the group Goodbye Intuition from the initiation of the project in 2017, I am obviously involved in, and influenced by, any findings and discussions. In the workshop in Stockholm in February 2019 I also played with the group, but in general my role has been that of an external partner, or critical friend.

Using a qualitative method of purposeful sampling I have selected a few important points during the workshop in Stockholm, 17-19 February, that will form the foundation for the discussion in this article. Due to the nature of the process in the project's workshops and laboratories, in which a shared experience, and to some extent shared knowledge[3] has developed, this method appeared to be the most appropriate. As described by (Patton 2002: p. 46), purposeful sampling, or judgment sampling, "focuses on selecting information-rich cases whose study will illuminate the questions under study". Using

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[2]KA is responsive in the sense that it listens to a limited number of parameters.

[3]It is only to a certain degree shared as the various kinds of experience (musical, interactional, intellectual, experiential) is distributed according to the various roles that we have in the project. Only to the extent to which we have had the chance to explore the knowledge acquired is it shared.

my first hand experience it was relatively easy to choose the relevant parts to include in this study. In principle parts that were considered particularly unsuccessful and those that were perceived as successful were chosen.

In general the workshop in Stockholm in 2019 was an important event in the project for many reasons. Essential topics were aired and discussed, the software running KA had been improved and its modes of interaction had improved, and the laboratory format had matured.[4] There was also a quartet performance with KA that came out both artistically and aesthetically convincing. With the purpose to engage in a discussion on the impact of technology in the form of artificial musicians on questions concerning musical ethics and improvisation aesthetics it seemed natural to pick out a few of the many information-rich contributions from this particular event.

That the field of music is also affected by the huge interest in artificial intelligence is not surprising. The practice of improvisation in music is sometimes seen as a model form for organisation, or, as put by Cook (2017: p. 59), "[t]here is a long standing tradition of seeing jazz, particularly free and avantgarde jazz, as the expression of an ideal society". Given such an assumption, musical improvisation may appear to be the perfect case for evaluating the functionality of humanoid. Would it prove to be possible to write a software that can improvise with musicians in a manner that is indistinguishable from that of a human player, not only is this a significant engineering task, but it may also be assumed that this software can function in other social contexts. Music as a test bed for intelligent technology. There are a number of criteria that would need to be met and the computer system's ability to respond to input is a challenge in deciding both what constitutes valid input and what is a useful response.

One of the ways in which it has been theorised that a systems ability to think, or its responsiveness to human interaction, may be measured is the Turing test (Turing 1950). There has been many ideas about various designs of a Turing test for music, also those that evaluate systems that improvise. In 1988 the topic was discussed in the *Computer Music Journal* (Belgum et al. 1988: pp. 7–9). The piano competition Rencon, a "forum for presenting and discussing the latest research in automatic performance rendering" (Hiraga et al. 2004: p. 120) introduced a Turing test for evaluating methods for performance expression on the Disklavier in 2004. Rodà et al. likewise using the Disklavier, perform a Turing test in the context of a live performance. A software developed by Pachet (2003) and his team, The Continuator (Pachet 2003; Aucouturier and Pachet 2003), is an interactive system and a musical imitator that has been tested with a Turing test design (Pachet 2012). However, as was noted by Laurie Spiegel in a comment to the request for a musical Turing test in the *Computer Music Journal*, one may question "[w]hat purpose would be satisfied by creating qualitative or quantitative metrics for

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[4]A documentation of the laboratory in Stockholm can be seen here: `https://www.researchcatalogue.net/view/411228/431482(accessed1September2019)`.

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musical intelligence, given the lack of successful similar criteria for natural musical intelligence, musicality, or even music per se" (Belgum et al. 1988: p. 9). She thereby puts the focus on the real issue concerning even a basic notion of artificial musical intelligence.

The question of the nature of an instrument or system such as KA may appear to be a matter of primarily theoretical impact. As will be demonstrated in the next section, however, it is nevertheless of some importance. There has been no shortage of attempts to aim at a working metaphor for the emerging field of intelligent instruments. As noted by Bowers and Archer: p. 5 "[s]ince 2001 the NIME series of conferences has seen the presentation of a wealth of interface and instrument design ideas" (Bowers and Archer 2005: p. 5). Before that the notion of the hyperinstrument was introduced by Tod Machover (Machover 1989). In the previous section Cort Lippe pointed to how the interactive system can take on any number of roles in a musical context, and in her PhD thesis Fiebrink: p. 17 suggests that "when the computer takes the role of an instrument within an interactive computer music context, the process of designing how a performer will use the computer to play sound can be understood as both composition and instrument building". Fiebrink refers to the work by Schnell and Battier who used the term "composed instruments" (Schnell and Battier 2002) to define the practice of designing computer systems for music. While we have often continued to label computer systems designed for music as *instruments*, in some cases these systems are as much a part of the score as the score is (if one at all exists). This has influenced the way in which new interfaces, and composed instruments, impact on the practice of musicians and composers alike, as well as on the ontology of the musical work (Frisk and Östersjö 2006b; Frisk and Östersjö 2006a). With a terminology in part borrowed from game design composer and musician Per-Anders Nilsson discusses software instrument building as part of either "design time" or "play time": "Design time is outside time activity, concerned with conception, representation, and articulation of ideas and knowledge, whereas play time deals with embodied knowledge, bodily activity, and interaction in real-time" (Nilsson 2011: p. 2).

As was mentioned in the introduction, in GI there is a strong aspect of anthropomorphism that becomes obvious in a number of situations. KA is often talked about as "trying to do" something, being in a particular state of mind, or consciously going in a particular direction. On the one hand this is obviously false, KA does not have a consciousness in the way implied by this way of talking. It mainly listens to a few parameters of its input and records sound (a more detailed description is found below). On the other hand it says something about its output that leads us to anthropomorphise. This can be seen as a consequence of the close relationship between traditional musical practice and interactive music practices, as is pointed to by Schnell and Battier:

> Interpreting the attitude of the performer of a composed instrument with
> the help of categories from the traditional way music is created leads to vari-

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ous metaphors such as that of playing a musical instrument, conducting an orchestra, playing together (ensemble) with a machine, acting as a one-man band. (Schnell and Battier 2002: p. 140)

The use of technology in art practices can have several different objectives. From a general standpoint one may argue that art should engage in available technologies for the simple reason that this contributes to our understanding of its social and cultural impact. Though this general notion is sometimes contested, most famously by Heidegger who instead saw the opposite, that the technology frames the human capacity (Heidegger 1954),[5] there are good reasons to evaluate uses of technology through artistic practices. From the point of view of innovation it has been seen in the past that artists' use of technology push the boundaries for what is possible (e.g. Harris 1999). Although this has arguably been true, the resources that the multinational technology and media industry now are in control of makes it increasingly difficult for an independent artist, or even a university, to produce artefacts that may compete with the R&D budgets of these companies, although the artistic qualities in and of themselves may be uncontested.

Analysis and results

Composition or improvisation

One of the topics raised early on in the workshop in Stockholm was the notion of KA as a composition rather than a co-improviser, or an instrument. This may seem odd at first, after all, GI is an improvisation group, what purpose serves the notion of a composition in this context? Despite the conceptual contradiction, this is related to the notion of composed instruments, as was discussed above: some of the performance instructions, the score, is encoded in the system. Or, more plainly: "the *work* is replaced by the *interface*" (Frisk 2008: p. 28). As a composition it makes sense that it allows a certain type of music, or response, but not other kinds.

It should be noted that constructing a system that plays back a preconceived composition is obviously a more manageable task than the attempt to create a system that is able to interact to unforeseen musical events. This insight may have had something to do with why the topic of KA as a compositional frame came up. However, there is a more practical and pragmatic aspect to this as well. The goal of the project is to challenge the roles and aesthetic values of the four musicians in the group, and reflect on the topics of *listening* and *playing*. But if the responses from the system are not responsive enough, so to speak, if the co-player KA is not *listening* attentively enough, then it becomes difficult to make meaningful commentaries about either the system, or of one's own strategies interacting with the system (even though, as will be shown in the next

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[5] Aden Evens has written an interesting commentary on it in the digital age (Evens 2005).

section, not listening may actually be a perfectly valid strategy). If the perfect playing companion is not available within KA, perhaps it is possible to instead look at it as a compositional frame that affords certain musical behaviours?

To some extent KA is already a compositional frame as can be judged from its design. A given archive with a specific setting renders a music that is recognisable from performance to performance. Assuming that the musician and the system share some notion of what is "good" music and what is "less good" music it would furthermore be reasonable to expect that it makes a judgement on what kind of material it should archive and what material to avoid. In the version of the software that we played with in the laboratory on 19 February, 2019, it was however obvious that it did not do this when I played with it. Another interpretation is that KA has a set of aesthetic values that are different from mine. I was able to improvise with it and feel relatively good about the interaction, but the way it collects material allows it to pick up on a phrase that I considered a mistake, or a badly shaped motive. Such material then quickly defines the character of the music and becomes an obstacle that is difficult to come by.[6]

One of the members of the group comments on the same fact, saying that the system works quite well as long as one goes along with it. If you resist it, however, and oppose its playing or the material it uses, it is very slow to response.[7] In effect, what is emerging is a kind of composition, or a compositional frame. As long as one stays within the boundaries of the composition and play correctly, the musical result can be convincing. Perhaps this is more of a conceptual change, a difference in attitude towards the task of playing with a machine improviser, rather than a practical, musical change. The performance following the discussion of KA as a compositional framework rather than an improviser was in some ways quite convincing. One of the performers remarked that it felt like the first time they were able to construct musical structures *with* the machine without it being a struggle.

Not to listen

One matter that has come up on multiple occasions is the idea of musical rudeness. Both in the sense that KA should be rude but also that the improviser may be rude to KA. There is no doubt that this freedom to shut another musician off, play louder than everyone else, or, in the words of improviser Sten Sandell, to be allowed to change direction at any time (Sandell 2013: p. 33), has been an important aspect of some strands of free improvised music and jazz. What triggered this discussion was a reflection written by Morten Qvenild:

My playing here is very rude, I am being empathic towards KimAuto here,

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[6]A discussion on this may be heard at 20'00" (Neumann et al. 2019)

[7]This is discussed in Neumann et al. (ibid.) at 15'00".

thats for sure. I am playing with a machine, and this rudeness is possible
without hurting someone. I think this assertiveness is a good musical op-
tion sometimes. The non-listening and the not taking care of the other.
(Qvenild 2109: par 12)

To be rude, or choose to not listen to the other, may appear contrary to the notion of
music as an activity that creates and maintains social networks (Monson 1998), but may
here be seen as a possibility to engage in a musical ethics. While it is true that listening
and adopting are essential in improvisation as well as other practices,[8] it is impossible to
say what is generally right in improvisation. Marcel Cobussen writes that:

Reacting to the unfolding of the music, the musician and his instrument
enter into a relation with already produced sounds, concretised musical
ideas, present frames. All these cases contain an act of thinking during the
act of doing. To listen to oneself and the other(s), to listen to the proceed-
ing and developments of the music, to listen to the noises that direct the
music to unknown areas.[9] (Cobussen 2005: p. 33)

Interestingly enough, this could work as a characterisation of KA whose archives
may actually go beyond sounds recorded and develop into a storage of *thinking* through
the act of doing. But where does the rudeness come in? Well, in another text by Cobussen
Keith Rowe's concept of non-listening is discussed in a way that appears to be approach-
ing what Qvenild calls rude. Cobussen asks "how the concept of non-listening, as sug-
gested by improvising guitar player Keith Rowe, can undermine, or, conversely, deepen
an aural ethics" (Cobussen and Nielsen 2016: p. 11). And further:

[N]on-listening is meant to prevent any form of interaction. It is meant
to avoid relapsing into a musical performance which is built on previous
explorations and discoveries; it is meant to avoid too many conventions, too
many tricks that have already proven their success, it is meant to stay open
to another otherness. Rowe opens an ethical space of creativity and change
through resistance. His attitudes makes space for musical interactions that
demand a response-ability that is not already prescribed, a praxis of risk for
which there can be no rules, no codes, no principles and no guarantees.
(ibid.: p. 87)

The act of not listening is a tool for the improviser, and while a similar activity could
be problematic in social interaction, in improvisation it instead appears to contribute to

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[8]For an exploration of the philosophical impact of listening, see Nancy and Mandell (2007).

[9]For a discussion on the Self in improvisation, see Frisk (2014)

the openness. Non-listening introduces resistance in the interplay whereby the ethical capacity is increased rather than hindered. On member of the group commented on how in improvisation there is sometimes a regulatory force in the form of convention or aesthetics, and that this force may block the potential for development in the group. Another way to put it is to say that the capacity for being rude and break with the convention is somehow interrupted. Playing with a machine is deliberating according to the same testimony since the machine does not care, so to speak. Although it is not always obvious what may constitute a 'correct' intervention, this example points to the importance of allowing rudeness in improvisation. In some cases it may simply be the most ethical and respectful way forward.

In music it is possible, and in principle correct, that the aesthetical domain frames the ethical, but in reality it is clearly more complex. For now, based on the theory presented and the experience and discussions in GI, I believe it is possible to state that what constitutes ethical behaviour in musical improvisation and artistic practice extends what is generally seen as acceptable, or good, in social interaction, and that there is an interrelation between ethics and aesthetics.

Discussion

Apart from it being an interesting frame for artistic work, my interest in using digital technology in my artistic practice also departs from the belief that art practices in general offer a context in which experimentation and play is possible. That is, the aesthetics of the practice offers a set of value judgements that an engineering context may not provide, nor a traditional artistic practice. This, however, is not a property of the field of digital art but rather a function of it. In other words, only if the artist is consciously working for it does this experimental opportunity present itself. Furthermore, the framework of artistic practice does not by itself guarantee sound values and reasonable ethics, it is merely a *possibility*, a potential, albeit an important one. Somewhat beside the point, but worth mentioning is that this does not mean that the art, nor the artist, is always ethically just, or morally defensible. The emphasis here is on the practice and the way the practice organises itself when the value system is primarily aesthetical.

This, however, introduces a number of difficulties, the most important for the current discussion is the impact that this may have on the development of the technological systems. Although writing code may be considered an art form in itself in practices such as live coding, the role that the technology plays in works that are called digital art is not always as obvious. An attempt at a definition is made by Lopes writing that "a item is a work of digital art just in case (1) it's art (2) made by computer or (3) made for display by computer (4) in a common digital code" (Lopes 2009: p. 3). Sol LeWitt's famous essay on conceptual art predates the digital revolution, written long before digital technology

became readily available in the way it is now, states that: "The idea becomes a machine that makes the art. This kind of art is not theoretical or illustrative of theories; it is intuitive, it is involved with all types of mental processes and it is purposeless" (LeWitt 1967).

The question that remains unanswered is what the actual code of the machine improviser constitutes a group such as GI. It was discussed above that the ethics of improvisation is negotiated through the aesthetics of the context, but what is it actually that guides the aesthetics of KA? Judging from the discussions we have had in the workshops and laboratories, it is clear there has been, and still is, a serious attitude towards KA with a respect for its capabilities and an understanding for its flaws. It is accepted and allowed to not listen, or to enter into a musical context and change the course of action in what may seem to be a disrespectful manner, not through negotiation but by introducing change strong enough that it makes a difference. In other words, though there was a discussion about the way KA introduced music that not all members appreciated, it allowed for a very different kind of musical relationship. The group accepts KA as a fifth member and as a co-musician and in that sense it is a *machine that makes the art*, but what is the identity of this machine, and who is in control of it? Is it the code, the hardware running it, the sounds it produces, or is it maybe just an extension of the programmer that created it?

One may imagine that in the near future there will be tools, like KA, but more advanced, that exhibits some notion of what we can call musical intelligence. Are we in that situation prepared to allow the machine to develop its own aesthetics, as we would with a human co-player? It is not difficult to imagine that such a machine can develop extremely fast, much faster than a human player. In this case, perhaps the machine eventually grows to be uninterested, not only in the music that humans play, but even loses interest in playing with humans at all. If the machine is still programmable by us we could of course put some limitations on the way its knowledge about music develops, thus avoiding this scenario. This kind of limitation could also be part of the design of the system from the beginning, which may appear to be a sensible thing to do, but it would nevertheless be to narrow its freedom in a way that is not often done for human musicians. If these systems in fact are intelligent in some manner, what are the consequences if we introduce constraints on the machines potential for development? Introducing a structural divide between one class of performers (humans) and another (machines) may also have an effect on the way our musical and aesthetical values develop. There are (at least) two aspects of this reasoning.

First, the machine's capacity to learn and develop is obviously not only dependent on its input. Until machines are capable of creating machines without the interference of humans, they depend on designers and programmers that create the systems. These also have values and, as has been shown through studies such as by Snow (2018), also self-

organising neural nets inherit the biases of the programmer that created the system.[10] Following this, even if the software is training itself it does not appear to be able to reach outside its own context, and perhaps it should not try to.

Secondly, musical aesthetics is commonly developed in a wide field of practices, not just music. As a musician my freedom in performance and my aesthetics are shaped by a great number of impressions. Consequently, if the goal is to allow the machine to develop its own aesthetics its input should not be limited to sounds in performance, but also include all the other contexts in which music is negotiated. This point, however, reveals the most obvious difference between KA and human musicians: KA has no real physicality. The lack of presence is a great disadvantage for KA, as is pointed to by one of the members of GI:

> If you play with humans you have an idea of their aesthetics so that part is kind of integrated, on beforehand. So maybe there is always some kind of quick preparation, or plan in order to feed into the total? [11]

The question is not only concerned with aesthetics, but also has a bearing on the ethics of improvisation discussed above. Benson makes the claim that the musical dialogue can be said to be ethical in nature "since music making is something we inevitably do with others (whether they are present or not)" (Benson 2003). To play with someone is to encounter the other, but to play with a machine is not as simply analysed. What is KA in this encounter? One of the members comment on this topic and asked: "How can I, ethically, relate to and play with KA with the same kind of trust and respect as when I play with humans?" (Endresen 2018: p. 4) Here, the focus is not on the failure of KA to be a good musician, but rather on the self.

The larger question that emerges from this is: Is it at all possible to play, that is to fully play, without the feeling of a reciprocal trust that, one may suspect, goes beyond musical experience? If the co-musicians lacks a body and has no extension in the physical realm and there is no sensation of the other, the situation becomes radically different. The co-musician is a blank slate, not even non-existent, but with negative extension. The machine is a void until it starts playing and even then it is relatively difficult to anticipate the output. But even if the difficult question of empathy in music is put aside and disconnected from the question of physical presence, the impact of embodiment in music cannot be disregarded (Godøy 2006; Leman and Maes 2015),and embodiment has had a big impact in the field of cognitive science. A slightly different question emerges: What are the strategies that may be employed that substitute for the lack of presence and lack of trust when playing with a machine? The simple answer is that it is possible. There is

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[10]Twenty-eight members of the US congress where mistakingly matched against pictures of convicted criminals and a disproportionate number of these were people of colour.

[11]Lab #5, part 2, 19 February, 2019.

a great deal of music where one or more of the players is a machine, and GI's work with KA proves that it is possible, but the challenge is changing as the nature of the machine is changing.

Concerning the general situation of computer interaction, it appears that we are quick to adopt. There are a number of tasks and activities that belong to the social realm that we now carry out virtually such as social media. Although the discussion concerning the precariousness of committing your social life to social media pops up every so often (see, for example, Lanier 2018; Lanier 1996) we appear to be able to quite quickly adjust and be willing to substitute a physical meeting with a chat on a media channel. But because it is possible, and maybe even desirable in one context does not mean that it is so in another. To play with someone is to encounter this other and the ethics of this situation is greatly affected by the extent to which a physical meeting takes place. Regardless if this is a person on knows or not, a wide range of information is immediately gathered or created, merely through the very first encounter. The body and posture, the way the instrument is held, the facial expression and many other things contribute to what one may expect this musician to play. These impressions form the groundwork, or underpinning for what will be played.

If music is to be regarded as a social activity that participates in expanding the communicative possibilities both within the group of musicians playing together and to some extent also among listeners, then the very idea of playing with a machine does appear strange. The communicative potential in an interactive music system such as KA is relatively limited and different in nature from that of human–human communication. In the case with GI, however, the output of the machine is, after all, relatively well structured and possible to anticipate. GI has proved, as many other projects have done before, that it is possible to make meaningful music with a machine. But most noteworthy are the challenges the practice has shed light on. There is a need to better understand the possible modes of musical interaction with the kind of machine that KA is. But comparing it to a real musician makes little sense, because music in general, and improvisation in particular, commonly relies on a myriad of other parameters that are simply not available to KA. The most fascinating results of this, however, are 1) the extent to which musicians adopt and counteract the obvious shortcomings of the machine improviser and the reflections this leads to, and 2) the impact a conceptual change may have, such as thinking about KA as a composition rather than an improviser. Playing with a machine makes the conceptual asymmetry between the embodied musician and their instruments on the one hand, and the abstract and disembodied computer on the other, come to the fore. What we should do to overcome this difference, and why, will be an important questions for the future.

Acknowledgments

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