RENEGOTIATING RESPONSIBILITIES IN HUMAN-COMPUTER ENSEMBLES

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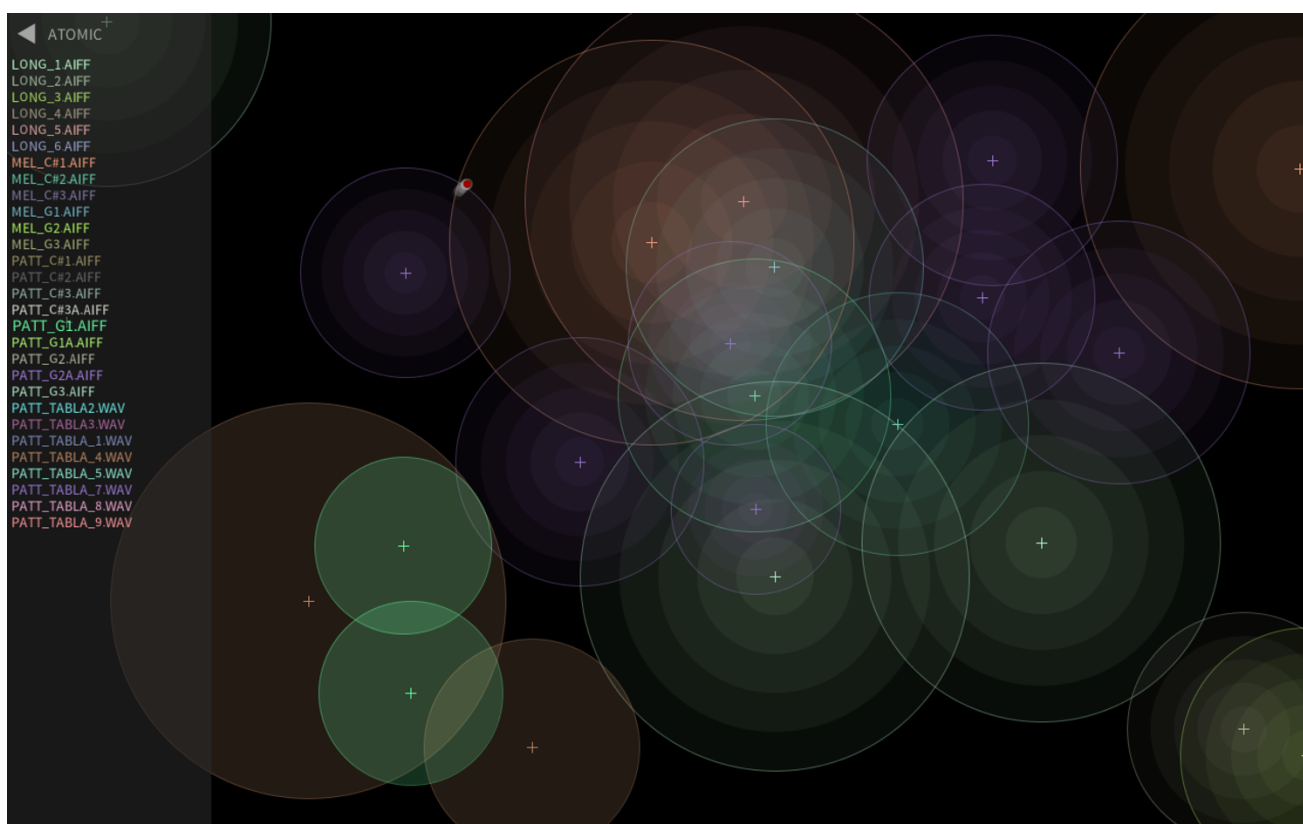interAction Lab
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Figure 1. Chimney, the software used as a probe to reflect on new scenarios of human-machine collaborations.

ABSTRACT

This paper proposes discussions for the (re)negotiation of responsibilities in performances that involve a collaboration between human and computer agents. Most of current research is human-hierarchical, leaving the machine the role of a mere tool at performer's service. In this paper a more balanced distribution of responsibilities between the two agent is proposed. Chimney, a software developed by one of the authors, is proposed as a design probe to reflect on this topic. Chimney allows the composer to control only the musical material of a piece, leaving its evolution to an algorithmic agent whose decisions are unpredictable. This redistribution of responsibilities results in a compositional shift that causes the roles of the composer / performer to overlap. The implications for the experience of the performer operating Chimney are also discussed.

1. INTRODUCTION

At the dawn of the last century, the digital revolution offered musicians and researchers the possibility to explore new forms of musical creativity using computers. Besides offering unprecedented interaction possibilities thanks to novel instruments and interfaces, musicians started experimenting with new compositional strategies by detaching human responsibilities to the compositional process, which were partially or completely delegated to computers. Such strategies had been extensively explored by George Lewis, one of the pioneer musical pieces that "emerges from a nonhuman intelligence" [1].

In his work, he explored performance interactions between improvising musicians and computer programs that create new music material at performance time.

The work described in this paper keeps up with the encounter between human and algorithmic agents to collaboratively operate to create new music. In particular, we propose discussions about the role of the machine in such hybrid ensemble. Traditionally, computer agents have been relegated as tools to serve the performer. We here advocate a more equal redistribution of the roles of the two agents. Chimney, a software that shares the control over the performance between the musician and the computer, is presented as a probe for discussion. In Chimney the musician-part of the control over the composition is reduced to (i) selecting the musical material to be played during the execution; and (ii) deciding their likelihood of being played temporally closer to each other.

To emphasise the non-hierarchical nature of the ensemble, a visual identity was assigned to the computer agent. An algorithmic *random walker* unsystematically roams throughout the screen: as it encounters an object, the sound associated to that specific object starts playing with a sound level which is proportional to its distance to the walker. The human agent can only decide the objects to be placed on the canvas, their position, and their size. Under these conditions, the musician cannot organise a temporal structure, which is entirely controlled by the algorithmic agent.

Such renegotiation of responsibilities results in two principal compositional shifts: (i) the music is no longer organised according to the phraseological-temporal structure; (ii) the sound objects become the focus of the composition. As a consequence, the system fosters the musician to elaborate new compositional strategies.

It is worth remarking that the scope of interest of this paper lies beyond music and art domains. Chimney belongs to a recent corpus of work of the authors which aims at as well as other works from the authors [4] [5] that encompass reflections on philosophical and cultural concerns. Our pieces are probes that pose questions and speculate about possible future scenarios of computational art. For instance, what would be the consequences of (partially) delegating artistic creation to an autonomous agent? How would the role of art and the artist change?

The remainder of the paper is structured as follows. The next section presents the technical details of Chimney; Section 3 describes the computational shift that a composer needs to face when utilising this system; Section 4 presents Alinearity, a piece written by one of the authors for Chimney and a trumpet; Section 5 discusses more insights about the experience of the trumpet player that interacted with the system.

2. CHIMNEY

Chimney is a multi-platform open source application developed with Processing[1]. Quite an efforts was made to build a strong visual identity to the algorithm for two reasons: (i) to provide the algorithmic agent a *character*, thus emphasising the absence of hierarchy between the two agents; (ii) to help the audience understand the performance. The visual interface is composed of a *canvas* that displays the status of the algorithmic walker and the sonic material.

2.1 The random walker: the fly

The canvas is initially blank with the exception of a particle - the random walker - that moves throughout the screen. The idea was to give the walker a behaviour that recalled that of a *fly*. For this reason, we based the *fly* on an adapted version of the Perlin Noise [6]. The Perlin Noise is a random generator function originally developed to produce natural looking textures on computer generated surfaces. This function produces a more natural, harmonic succession of numbers than that of pure random functions.

To the original Perlin Noise function we added a few features to match a our requirements. In particular, the *fly* had:

1. to cover the entire space of the canvas;
2. to be independent of the presence or absence of other objects in the canvas;
3. to have non-deterministic movements: the path taken by the *fly* cannot be predicted nor controlled in any possibly ways by the musician.

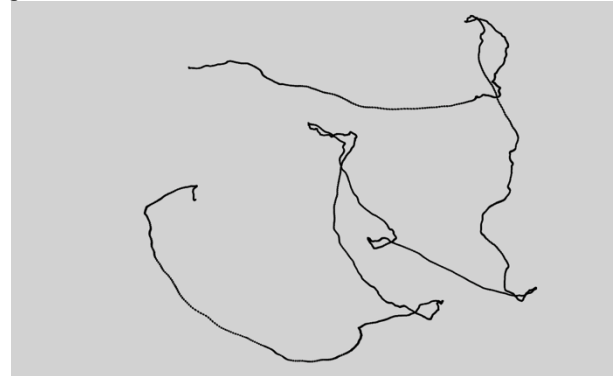Figure 2 shows a possible path taken by the *fly* over a period of two minutes.

Figure 2. A possible trajectory of the fly.

2.2 The compositional material: sound circles

The performer can interact with the canvas by adding sound sources to it. These sound sources are displayed as circles (Figure 1), whose placement and radius can be controlled by the user interacting with the mouse. Once positioned in the canvas, the performer can interact with it by changing its size, by repositioning it and by deleting it. Every time a new circle is added to the canvas, the system sets it in idle state and mutes it. As the *fly* enters a circle, the sound connected to that circle increases. The maximum level is reached when the *fly* is at the centre of the circle.

The sound sources are made of pre-recorded excerpts stored as audio files. The user can access these files through a sidebar that lists all the sound files contained in a specific folder (Figure 1, on the left). Once selected

a new sound source, the next circle to be positioned in the canvas will be associated to that sound source. A colour code helps identifying what sound each circle is associated to.

3. COMPOSITIONAL SHIFT

The theoretical ideas that lie behind the compositional approach to Chimney was based on the early approach to composition and improvisation of John Cage. In particular, during his first improvisation period (following the Feisst's analysis of Cages' work [2]), Cage categorised compositional process as a fourfold activity composed of: structure, material, method, and form. The *structure* is the temporal division of the sections, the *material* consists of the sound objects (including noise and silence), the *method* is the "note to note procedure", and the *form* is the "morphological line of the sound-continuity". Following Cage's opinion, material and methods can be both improvised and composed. Form cannot be composed but only improvised, as it results from the sum of the other activities. Finally, structure is the only element that cannot be improvised.

Having control on the structure allows a composer to be in charge of the evolution of the piece. In fact, he can move back and forth on the music timeline. Sarath formulated this concept proposing the term *expanding temporality* of a compositional process [7]. Given that the composer does not work at performance time, the musical decisions are not directly influenced by the previous events. The composer can *freeze* time, re-think passages, and anticipate future musical phrases. As a result, the development of the piece is based not only on previous events, but also on the anticipation of the material to be presented at successive moments. A different kind of temporality is the *inner directed temporality* [7], a concept proposed to describe the evolution typical of improvisation. When improvising, a musician cannot precisely anticipate how the music will develop. Thus, improvisers can mostly focus their attention on the present, with little attention to the near past and future.

Chimney offers the composer the possibility to redefine the edge of composing and improvising. Given that the temporal evolution of the piece is not under his or her control, the structure can no longer be composed. Chimney restrains human control over the development of the piece as the composer cannot step back and forth and recompose a particular event. As the music is shaped at *run time*, the performance itself represents the final compositional process. As a consequence, performing with Chimney requires an *inner directed temporality* approach. However, at the same, it is not pure improvisation: despite the freedom to take real time decisions the performer cannot improvise the actual musical material.

The musical *material* itself is the element that bounds performance to composition. The musical gesture, limited to organising pre-composed music, is composed outside before the performance, thus it is closer to the concept of *expanding temporality*. The musical material becomes the very core of the piece and can be seen as a meta composition of the music, which ultimately generates at performance time.

The *method* touches both the compositional and the improvisational aspects of music making. It is involved both in the creation of the sound sources and the strategies adopted to place them on the canvas. The *form* and the *structure* are both determined during the performance, and consequently are improvised elements.

4. ALINEARITY

This section exemplifies the innovative aspects of Chimney by presenting *Alinearity*, a piece of music composed for Chimney by one of the authors. Alinearity was composed to provide the performer with the necessary degree of freedom to properly interact with Chimney while maintaining a degree of harmonic coherence. The piece can be performed as a solo piece for Chimney or as a duo for Chimney and a melodic instrument. *Alinearity* was performed in 2015 at the International Society for Improvised Music Festival (Château-d'Oex, Switzerland) in a version for Chimney and 10 string electric guitar and in 2016 at the International Conference on the Design of Cooperative Systems 2016 (Trento, Italy) for Chimney and Trumpet.

4.1 Description of the piece
The most important aspect of the compositional process adopted for Alinearity is the creation of sound objects as the main elements of the piece. The musical form is not determined by the development of musical material moving toward a specific section. Thus, there are no cadences and the material itself does not evolve. The development of the piece is based on the overlapping of different sound excerpts that create different situations. The musical form is shaped by the very transit of the *fly* through different cluster of sounds (the circles in the canvas). This transit can be gradual or sudden, depending on the behaviour or the *fly*.

The musical material was composed to be congruous and at the same time to open a wide range of possible combinations that guarantee coherence and expressiveness to the piece. It consists of 20 short monodic musical excerpts, each with a timbral, melodic, harmonic, and rhythmic value pre-recorded using a synthesiser made with Max-Msp[2]. The synthesiser is controlled with standard MIDI messages.

4.2 Harmony
The harmony of the excerpts is organised as a politonality over two tonality centres: Gmin and C#. The note of the excerpts can either belong to one specific scale or to both scales (C, which enharmonically corresponds to B#, F#, and Bb, which enharmonically corresponds to A#). More specifically, the musical excerpts are harmonically organised as follows:

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[2] https://cycling74.com/products/max/

- 7 excerpts belonging to Gmin;
- 7 excerpts belonging to C#;
- 6 excerpts belonging to both tones.

Their combination can create situations with distinct key notes, polytonal harmonies, or situations with a modal appearance that lacks a clear tonic centre.

4.3 Melody and rhythm

From a melodic point of view, the excerpts are clustered into three sets. They can be long pedal notes, very short patterns, and short themes:
- 6 long pedal notes;
- 6 short melodies;
- 8 short patterns.

The harmony of the six long pedal note belongs to both tonal centres. The short patterns have sharper rhythm and can create particularly complex polyrhythmic structures.

4.4 Timbre and register

The excerpts spread across five octaves. Long notes have low register and short notes have high register. As a consequence, the six long pedal notes are the lowest register, the six short melodies lays in the medium register, and the eight short patterns have the highest register.

The core of the synthesiser is a bank of eight resonant band pass filters, which processes white noise in input. The central frequencies of the filters are composed of a fundamental tone and its seven higher harmonic partials. The resulting sound can be accurately manipulated by interacting with its nosiness and brightness, as well as its envelope. Lower notes have a slow transients and a high level of nosiness. Higher notes have fast transients and low nosiness.

5. EXAMINING EXPERIENCES

Alinearity can be performed as a solo interface or in a duo with a melodic instrument. This sections analyses the different experiences of the musicians who (a) performs Chimney, and (b) plays the melodic instrument playing along Chimney.

5.1 Performing Chimney

Given that Chimney has been mainly operated by one of the authors, the following discussion is based on self-analysis of the experience. When using Chimney, composition and performance are superimposed. The emergence of this hybrid composer-performer was thoroughly described by Vallis [8][9]. The implications of this superimposition on the iteration strategies adopted during the performance are substantial. Four main gestures, or approaches to interaction, with Chimney emerged.

Placing excerpts and spectating the movements of the fly
In this first approach, the performer does not consider the movements of the *fly* at all. The gesture is guided by his knowledge of the musical material, thus by placing the excerpts on the canvas. The activities of the human performer have no effects on the musical output, who is relegated to being a spectator of the performer. Depending

3 An excerpt of the exhibition can be found at https://youtu.be/8-zVa1tN3Ak

on the movements of the *fly,* the actions of the musician can also fail to influence the music at all as the *fly* could potentially never reach the circles. From a musical perspective, this approach is the closest approach to traditional composition. Indeed, it operates in an *expanded temporality,* and all the performers' activities result in long term effects. This approach is typically adopted at the beginning of a performance.

Fostering a gradual passage to new situations
In this approach, the performer positions in the canvas a limited amount of excerpts and follows the movement of the *fly*. As a consequence, the control is more balanced between the human and the algorithm. The performer follows the changes introduced by the transit of the *fly* to a new circle by adding or subtracting elements from the canvas. This approach reduces the time spanning to a more localised present. The performer can focus on the previous events and on the changings that are occurring. The time window could be fairly wide but always centred on the present.

Following the fly to increase music complexity
In this approach, the performer closely follows the movement of the *fly* by adding circles to its trajectory. The human has the highest control over the composition, thus the stochastic aspect is consequently less influent. As the performer gesture are closely related to the movement of the *fly* the temporarily is more focused on the present, similarly to the *inner directed* case earlier described (Section 3). This approach is normally adopted to create local musical climax and results in a complex structure. Such complexity results from the number of overlapping excerpts that is achieved by adding several circles that follow the *fly*. The outcome is a much more complex texture articulated by a bigger number of musical objects. Furthermore, the music becomes richer and the quantity of rest decreases.

Removing all the musical excerpts
Chimney consents to delete all the excerpts that are visible on the canvas at once. In this case, the musical gesture is similar to what typically occurs with traditional instruments: to one action corresponds one musical outcome. The temporality is focused on the very time of the key pressing, but is influenced by recent developments in the music. This kind of interaction normally occurs only once during a performance at the end of the last climax. The sudden rest that results from this gesture resolves the tension and gently goes towards the end of the piece.

When Alinearity was performed as a duo piece for Chimney and Trumpet at COOP 2016 in Trento (Figure 3)[3], peculiar human-human interactions occurred. The shifting among the different approaches was determined both by the personal taste on the musical output as well as by the input received by the other musician. The trumpeter sometimes proposes shifting that did not follow the movement of the *fly*. The operator of Chimney - one of

the authors of the paper - who was controlling Chimney was thereby required to pay careful attention on the trumpet. In these case, gradual transits to new situations were not determined by the fly movements but rather by the other musician.
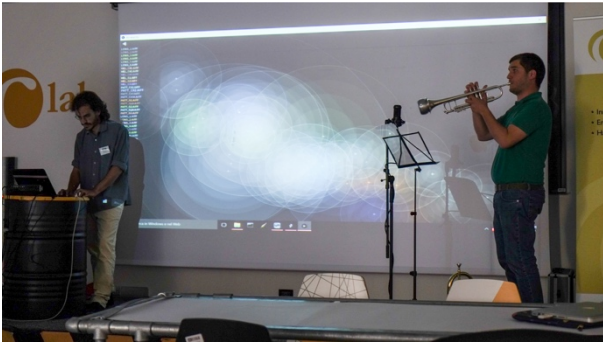

Figure 3. A trumpeter improvising along to Chimney.

5.2 Improvising along to Chimney

This section describes the trumpeter experience of playing along to Chimney. The trumpeter had no score to follow and was instructed about how the musical excerpts were composed. He was also given some time rehearsing the piece to become familiar with the software and the musical material.

After the concert, he was asked to elaborate on his experience of playing along to Chimney. The objective was to understand his musical strategies and to collect reflections about the interaction among the three agents (the trumpeter, Chimney, and the performer of Chimney).

The trumpeter reported that understanding all the details of the music played by Chimney was particularly demanding. In particular, as opposed to traditional improvisation, he did not feel free to propose new musical material. He was always answering to Chimney proposals. Each note, or phrase, was indeed primarily based on listening. As a result, his gestures were mostly about imitating, completing, or opposing what Chimney proposed.

From a musical point of view, the trumpeter was mostly influenced by harmony and rhythms proposed by Chimney. The approaches he adopted can be clustered into three main categories:

- using exactly the same notes of the excerpts;
- using the same scale of the excerpts;
- moving gradually from one scale to the other.

The rhythm could be influenced by the single pattern or by the overlapping of more than one. In the first case, the excerpts themselves determined the rhythmical result. In the second case, he was instead mostly influenced by the movement of the *fly*. With respect to the form, the trumpeter tended to follow the output of Chimney, enhancing his rhythm and loudness coherently with the overlapping of more excerpts.

When prompted to discuss his relation with the two other agents, the trumpeter reported that he experienced two distinct interactions. He perceived to be in closer contact with Chimney as he felt he was duet-ting with it. The performer controlling Chimney was only the access to ask something to the computer agent. Only in a few cases the main connection was between the two humans. This was particularly the case when the performer was following the *fly* or when he cleared the canvas. In these cases, Chimney was considered closer to a musical instrument.

He also commented that he would have preferred a higher complexity in the music generated by Chimney. In those situations, the trumpeter compensated for this perceived deficiency by increasing the rhythm complexity or the loudness of his instrument. To conclude, the inherent limitation of Chimney of having a limited material and being non-responsive fostered the trumpeter to find novel musical strategies.

6. CONCLUSIONS

Chimney was mainly developed as a design probe to reflect on the consequences of delegating part of the compositional process to an algorithmic agent. In this context, a number of negotiations between the human and the computer agent have to take place. The implication of such negotiations are evident from a musical perspective and from the performer's experience alike. With respect to the musical perspective, the focus of compositional effort shifts to the interaction strategies more than the form, and a number of compositional decisions are left to performance time. As a consequence, the distinction between composition and improvisation, which is neat in traditional performances, becomes blurred.

The disruption of built-in hierarchies of human-leads-computer-follows also caused a series of implications in the experience of the performer who is controlling Chimney and of other musicians that play along to it. Whereas some of these implications can be attributed to the non-responsive nature of the system, others are attributable to the distinctive character of the interaction. In particular, both Chimney performer and the musician that improvises along to it, are withhold the possibility to control all the aspects of the performance. Freed by a precise control on musical structure and declined the possibilities to have *veto buttons*, they need to surrender a more balanced collaboration with the algorithmic counterpart.

7. ACKNOWLEDGEMENTS

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