Generative Scores and Data Mining: *W.E.I.R.D.* Enters the Stage

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Abstract

W.E.I.R.D. is a suite for piano solo combining the practice of data mining with a generative musical score. Data mining is deployed to extract tweets containing a set of keywords related to the sociological perspective on postmodernity proposed by Zygmunt Bauman. Such keywords are used to trigger the generation of a score written in common music notation, to be performed in real time by a soloist. Through the combination of data mining and generative scores, *W.E.I.R.D.* introduces the influence of a large sample of society on the stage, thus expanding the performance to emerging contemporary social dynamics. The first two movements of the suite are described from a technical and compositional perspective, and two demonstrative videos are presented outlining how the COVID-19 pandemic has influenced their implementation. Finally, a brief outlook of this work within the field of modern aesthetics and a series of possible developments for such compositional approach are proposed.

Keywords

Generative Musical Score, Generative Composition, Data Mining, *W.E.I.R.D*.

1 Introduction

1.1 Data Mining in the Arts

Data mining is the practice of extracting valuable information from a vast set of raw data. The growing amount of information available in social media is favouring an extensive application of such techniques, for the most part automatically performed by software called *bots (*Maynard et al. 2012). The open structure of *Twitter* and the easy access to its *Application Programming Interface* (API) set this network apart from other social media platforms, in that most of the content is easily accessible and extractable (Kateb and Jugal 2015). Since *Twitter*'s foundation in 2006, the number of active bots inside the platform has been rapidly increasing, reaching in 2012 a proportion of 1:1 compared to real users (Chu, Gianvecchio et al. 2012), attesting the strong interest of private and public entities towards N*atural Language Processing* (NLP) technologies for the prediction of public sentiment on relevant social themes, commercial products and services.

Twitter bots are commonly used for sentiment analysis, viralization of contents, data-set development and research, but since their introduction artists have included them in their practices to playfully develop artworks both inside and outside the internet. For the purpose of this work, three categories of use for the creation of artistic outputs are described: bots analyzing *Twitter* and posting the content on the medium itself, bots mining content from *Twitter* and posting it on the web, bots extracting content from *Twitter* and projecting it into the real world.

The examples of bots that scrape *Twitter*, process and rearrange the content, and publish it inside the platform are numerous. *@Oliviataters*, programmed by Rod Dubbin, automatically tweets snippets of text posted by teenagers, in order to simulate Olivia's fictitious existence. *@Anagramatron* searches for anagrams and retweets the matched pairs. *@Haiku9000* retweets sentences that each fit the rules to become a one line haiku, thus depriving the author's words of their original meaning. *@Pentametron* uses tweets to form iambic pentameter poetry (Oliviataters 2021, Haiku9000 2021, Anagramatron 2021, Pentametron 2021). The approach of using the content produced by the community for the community itself is the most common because of the great advantage of an easy and broad diffusion granted by the medium, even though such bots might at times suffer the limitations imposed by *Twitter*'s policies to accounts posting repetitive or non consistent automated information[1].

Other bots mine *Twitter* to create original works outside the platform, and publish elsewhere on the web. The *Re-twittering Machine* (Plessas 2012) downloads tweets containing the word 'freedom', and incorporates them in an online dynamic drawing similar to Klee's *Twittering Machine. WeFeelFine* (Harris, Kamvar 2011) is a complex website and artistic creation delving inside human emotions: a bot looks on platforms and blogs across the internet for sentences starting with 'I feel'. The process repeats every ten minutes. The extracted data is then processed in a series of six movements, or graphic compositions. Each one represents a specific emotional nuance and displays information about the authors of the twitter content.

Less numerous are the works extracting information to display into the real world. The data is usually rearranged in order to build visual processes, as in the case of the *Mood Map* (Lee, Brush, Younse 2013) which displays through light the prevalent mood of people tweeting in South Korea , or the *Hello Cube* (Hellicar and Lewis 2012) which exists both in the real and virtual world, and dynamically changes in colour and shape following people's instructions received on its 'personal' account. Still visually oriented, but incorporating sounds and lights in a physical sculpture is *Bias* (Apnoa 2017), triggered by tweets containing one of the keywords monitored by the American Department of Homeland Security. More rare is the case of tweet bots interacting with the physical world only through sound. An interesting example of such an approach is *Twitterradio* (Morreale, Miniukovich, De Angeli, 2014). This interactive installation consists of a *graphical user interface* (GUI), a tweet bot, a server for *natural language processing* (NLP) query and an algorithmic composition software. The system retrieves all the tweets published during the preceding five hours and containing the keyword selected by the participant through the GUI. The tweets are analyzed through the MPQA Subjectivity Lexicon[2] which assigns them an emotional valence, from very positive to very negative. The result, normalized by the number of tweets, triggers an algorithmic composition software based on Markov chains. The average valence of the incoming tweets affects the acoustic outcome in real time.

1.2 Notation as a Dynamic System

The amount and the nature of the instructions given to performers through graphic signs have been changing throughout time, depending on the praxis, the available medium and the intention of the composer, but in all cases information is necessarily lost in the bidirectional process of fixation and translation of sound. In the Middle Ages the atomic written element of *plainchant* was the *neuma* (Grove Music 2001), a graphic sign representing a combination of sounds to be performed on a single syllable. The score was a set of symbols depicting musical gestures (Latin 776, XI DC). Since it lacked fixed reference points, it was used as a study and memorization tool rather than a complete notational system. During the XIth Century Guido D'Arezzo addressed the representational limitations of such an approach by adding two lines over F and B to indicate the half tone, thus allowing for monodic sight reading (Palisca, Pesce 2001). Still, the main technique adopted to vertically embellish the music over iterative motives was improvisation (*Cantare Super Librum*) (Vicentino 1555). With the development of polyphony (*Cantus Mensurabilis*), the need for a more

1 Twitter Automation Rules

2 MPQA Subjectivity Lexicon

precise notational system, especially in the rhythmic realm, got urgent: squared notes over a quadrigram were introduced to represent durations (Apel 1961). Notational praxis was adapting to the context, to the requirements of the music and the role entrusted by it to the musician.

During the sixteenth century, intervening over a score to introduce extemporary variations was common practice. Scores were often written assuming a deep stylistic comprehension by the performer as a necessary premise for his active intake. The most diffused approach to the extemporary intervention over a written score was *diminution*, the practice of introducing shorter notes inside longer ones in order to embellish the melodic line. Diminution was taught as a systematic method, by providing students with a set of examples on how to fill a specific interval (Acciai, Gatti, Tavella 2015).

With time, publishing music with written diminution became common practice, providing the composer with more control and the performer with defined constraints. A radical paradigm shift emerged in the midst of the nineteenth century, fostered by the effects of industrialization on academic art and by the secularization of repertoire: the figures of composer and performer began to walk on different paths, and the mediating role of the score became critical (Moore 1992). Even though some musical parameters had necessarily to be entrusted to the performer (Rink 1995), the scores became rigid and the musician's interpretative freedom extremely limited.

At the beginning of the 20th century the perspective shifted once again. The direct fixation and reproduction of sound provided by the phonograph coupled with the diffusion granted by the radio, allowed for the diffusion of improvised genres of popular derivation (Zenni 2012). At the same time, the pressure towards the dissolution of the tonal system after the post-romantic era, which culminated with dodecaphony, set the foundation for the emergence of a plethora of original approaches. The explicit attempt to defy the narrative continuity represented by tonality and the development of new approaches and technological means implied an adaptation of notational systems. In *Fontana Mix* and *Aria* (1958), John Cage superposes transparent papers to build generative scores and Cornelius Cardew in *Treatise* (1967) adopts lines, symbols and abstract geometric shapes as the basic elements of the score.

With the birth of computer music the possibility to automate the score's changes during performance was introduced, thus opening to an unprecedented palette of behavioral implementations inside the medium. Thanks to the aquired dynamic dimension[3] the scores began to react to the context with different degrees of freedom, shifting the composer's role towards the construction of structures containing a variable set of possibilities: a third way, in between the realms of improvisation and execution of written music had been introduced (Winkler 2004).

In generative scores, the sources providing data affecting the algorithm's behavior are usually sought inside the performative context, alternatively assigning the role of direct agents on the score's variability to the musicians, to the audience or to the algorithm itself. The *Anticipatory Score* (Wyse, Yew 2014) is an example of a generative score controlled by the performers themselves. Here, notation becomes a communication strategy for real-time musical interventions. In other cases the audience is endowed with the control of the generative algorithms. McAllister proposes a technique for using handheld computers as inputs of the audience's gestures affecting the score in front of the performers (McAllister 2004). Freeman introduces the use of video cameras pointed towards the audience as the input for score generation (Freeman 2008). Burtner's *Auksalaq* NOMADS (Burtner 2012) app and thematic opera collects, merges and displays the textual and graphical outputs from the audience's smartphones, organizing it in semantic fields affecting the performance. Burtner's opera unfolds around the listeners that, in real life as in the fiction of the play, are active participants in the dramatic process of ice melting in Alaska and Canada. Eigenfeldt suggests incorporating performing instrumentalists, instead of synthetic sounds, inside evolutionary computer-generated music. In his work *An Unnatural Selection,* common notation is displayed for the musicians and the conductor via eight iPads. The whole composition is generated by an evolutionary algorithm, thus

3 Animated scores by Steinn Gunnarsson and Ryan Ross Smith

remaining completely independent from the context yet different in every performance (Eigenfeldt 2015).

In all the aforementioned works, real time score modifiers are generated from within the performative space with musicians, audience or computer as agents. In search for further destabilization, I introduced a new unpredictability element from the outside. The piece described in this paper extends the agency to society as a whole by affecting the score in real time through the contribution of social media. Such an approach allows for the extension of the performance way beyond the walls of the concert hall, and provides a new, strong conceptual ground for the adoption of independent triggering variables in performative musical practice.

2 W.E.I.R.D.

W.E.I.R.D. stands for *Western, Educated, Industrialized, Rich, Democratic*. The acronym was first introduced in the 2010 meta-analysis *The Weirdest People in the World* by Henrich, Heine, Norenzayan. Their research exposed a bias affecting behavioural sciences, characterized by the false assumption that the small sample of population traditionally subject to experimental research and responding to the w.e.i.r.d characteristics, represented a reliable model for all mankind. The w.e.i.r.d. sample is traditionally defined within the realm of social sciences, but the geographical pattern of *Twitter* accesses and posting can be easily juxtaposed to the common indexes of wealth and education all over the world (Leetaru et al. 2013). At the core of *W.E.I.R.D.* is the work of Zygmunt Bauman, and the ideas proposed in *Liquid Modernity* (2000) and other coeval essays. Three keywords were chosen out of the reflections on postmodernity developed by Bauman, each one giving the title to a specific movement: *Uncertainty, Emergency, Identity*.

2.1 Technical Description

W.E.I.R.D. is a suite for piano solo, consisting of three components: a generative score in three movements, a tweet bot and a MaxMSP[4] patch. During the performance, the three movements should be sequentially projected on a large surface, so that the musician and the audience share the same point of view. On the right vertical half of the screen the composition unfolds. The left half of the screen displays tweets containing the keyword giving the title to the movement as they are posted all around the world. The tweets influence the score's behavior in accordance with a different set of rules for each movement. The details on how tweets and notation interact are not explicitly explained to the audience, but given the synchronicity of the events between the two halves of the screen, a correlation can be clearly perceived. Such an approach endows every listener with the freedom to correlate words, concepts and sounds, and grants intimacy and uniqueness to the experience.

The first component, common to the three movements and necessary for *W.E.I.R.D*. to access social media, is the bot. The Twitter API is accessed with *Tweepy*[5], an open source Python library. Once activated, the script downloads all the tweets containing the chosen keywords, divides them in short/long tweets —classification threshold is by default 140 characters — and new tweets/retweets. The tweets are then routed to MaxMSP via *Open Sound Control* (OSC) and displayed on the left side of the screen.

The way the tweets trigger events on each score is strictly correlated to the conceptual representation of the chosen keywords and to how each movement is imagined to act. Inside *Uncertainty* three scores coexist: an empty staff, the final refined version of the piece (A), and a score containing a more essential version of the composition, devoid of one melodic line (B). The three scores are divided into 24 parts, each one containing the equivalent of one bar. For each bar, a switch controls which of the three scores will provide the output image. The score displayed by default is the

4 MaxMSP

5 Tweepy

empty one. Every time a tweet containing the keyword *Uncertainty* is downloaded, the program assigns a bar from A or B to one of the 24 empty units. Tweet after tweet the composition appears on the screen, and since A and B are randomly assigned to each bar, the overall result is somewhere in between the two but always different. When most of the score has emerged—after about two minutes from the beginning—the musician starts playing. During the performance, the tweets trigger random variations between A and B thus producing unexpected results, but the coherence of the composition is preserved by the common origin of the two scores. A final, conclusive form is never reached though: uncertainty feeds the tension towards a defined structure, but at the same time prevents its achievement. The piece ends after one iteration.

In order to allow the live execution while the score changes in front of the player, many compositional aspects had to be taken into account. The most critical of them was the tempo, which had to be very slow for the musician to be capable of reacting to any sudden variation. This necessity became an interesting compositional artifice: the first movement, if played at normal tempo, has a pseudo tonal character. The tempo should be slowed down just enough for the horizontal, melodic element to lose its coherence and become a subliminal glue between isolated, vertical units of sound.

The second movement was conceived as a rhythmical and melodic counterpart to the first. In *Emergency* the score is divided in sections that are numerically ordered from one to five. The higher the section number, the more dense and dynamically tense the composition gets. Once started, the software checks the average number of tweets containing the word *Emergency* inside a nineteen-second span. The process repeats four times, and the lowest value obtained is associated with the first section, which then appears on the screen. The musician starts playing. If the number of tweets in the next nineteen-second slot is higher than in the preceding one, the next section appears, otherwise the score does not change and the player keeps repeating section one. From section two on, a higher number of tweets moves the composition to the next section, and a lower number to the preceding one. Once the last section is reached the tweet counting stops, and the whole movement ends after one repetition. The right half of the screen turns from black to white and vice versa every time the musician has to change sections, while the left one, like an alarm, blinks at a higher rate as the piece progresses.

2.2 Compositional Approach

Compositional choices were made to provide balance and coherence among the three different movements of this work. *W.E.I.R.D.* is composed over a twelve-tone series. The series is a constant compositional reference but it poses no strict rule: it is rather an artifice to establish a sense of harmonic ambivalence in each movement, and overall consequentiality throughout the composition.

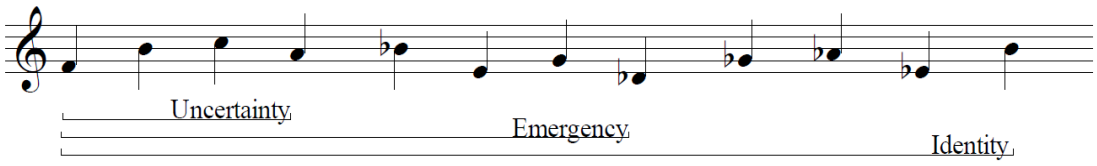

Fig. 1. *W.E.I.R.D. Dodecaphonic Series*

The first four notes of the series, which overlap in *Uncertainty* to produce chords, can be seen either as a Csus triad with a major 7th or a FMaj7 with a sharp 11th. In the first case (CMaj7Sus4), the missing 3rd does not consent a clear interpretation of the chord, while in the second case (FMaj7 #11) the Lydian derivation of the chord is a modal point of gravity from which any other possible outcome originates (Russell 1953). *Emergency* adds another set of four notes to the first four of the

series. This second group forms a diminished chord and since in such chords all notes are a minor third apart, any of them can be perceived as the root of four equal inversions (Bbdim - Edim - Gdim - Dbdim). Once again, harmonic ambiguity and ambivalence are used as a metaphor of the rootlessness and uncertainty of modern times. *Identity*, the third movement of *W.E.I.R.D,* will include the whole dodecaphonic series, with the addition of another group of four notes that, similarly to the first movement, can be interpreted as an Ab Lydian Dominant devoid of the third.

Even though its primary purpose is performative, W.E.I.R.D. can become a testimony of specific social dynamics, common emerging fears, issues at the center of the political agenda as in the case of the two demonstrative videos presented in this paper and recorded during the COVID-19 lockdown.

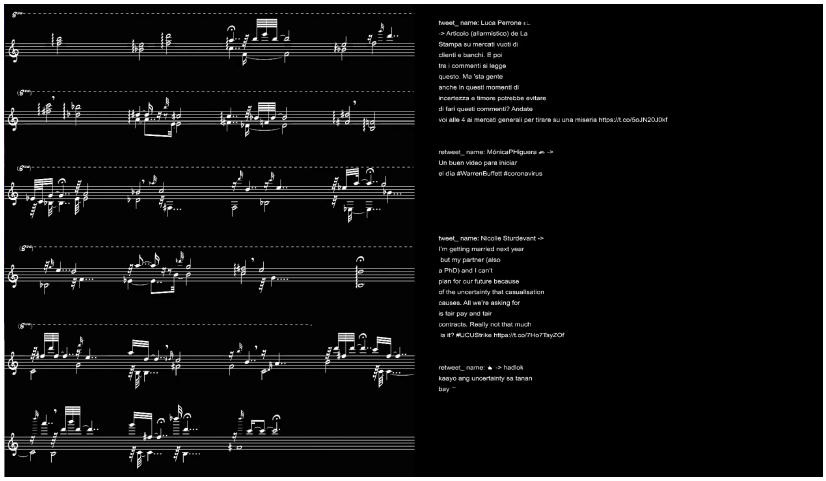

Fig. 2. *Uncertainty* **(**https://youtu.be/p_iR8aKaLJs

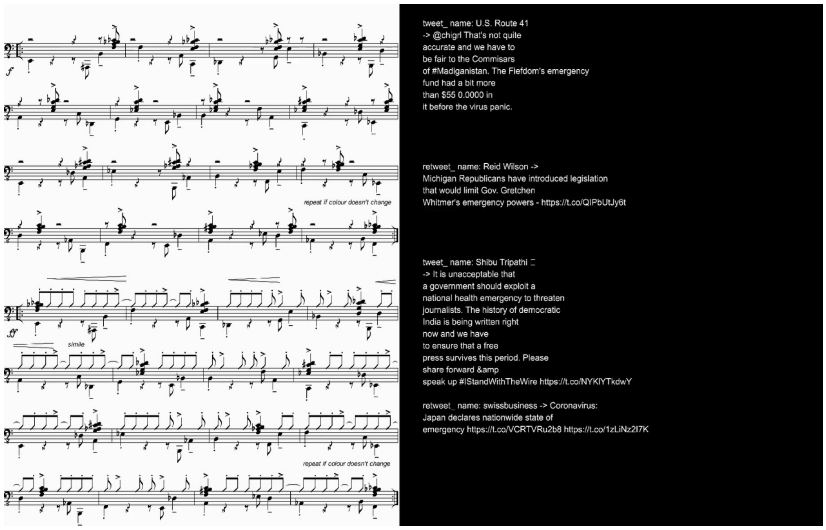

Fig. 3. *Emergency* **(**https://youtu.be/AD1hY5-Kk2s**)**

3 Conclusions

W.E.I.R.D. is a suite in three parts for piano solo, combining the practice of data mining with a generative musical score. Tweets, containing keywords that give the title to each of the movements, are analyzed in real time and trigger the generation and modification of a score performed by a soloist on stage.

Uncertainty, the first of the three movements, was composed in January and February 2020. My aim was to look for diffused states of anxiety inside society, that might be integrated into the composition. I had been inspired by Bauman's reflections on uncertainty as a trait of postmodern society caused by the rise of diffused precarization processes inside the public and private sphere (Bauman 2006). The successive recording coincided with the announcement and diffusion of the COVID-19 pandemic across the globe and the successive lockdown in Northern Italy.

The second movement, *Emergency,* was written in May 2020, in the midst of the first COVID-19 wave, when most countries were being severely affected by the pandemic and people's freedom of movement and social gathering had been reduced in an unprecedented way for western democracies. The dialectic between personal and collective freedom was at the core of complex political choices induced by the present state of emergency. Twenty years before, Bauman—in exploring the blurred line between public and private realms in postmodern democracies—stated:

> It is possible that an increase of personal freedom coincides with a growth in collective impotence in that the bridges between public and private life were broken down or never existed in the first place (Bauman 1999).

However, COVID-19 is not an isolated crisis in the unfolding of social experiences: emergencies pervade the public sphere as a destabilizing roller-coaster ride. It can safely be assumed that the second movement of *W.E.I.R.D.* will never be devoid of triggering tweets.

Because of social distancing imposed by pandemic restrictions, the first two movements of *W.E.I.R.D.* could not be performed in a public space yet. Nevertheless the two attached videos were sent to art galleries and journals as self-standing artworks. The video recordings were positively welcomed by numerous contemporary art organizations. Among others, The *Blackwood Gallery* published the movements in two successive issues of their journal *Tilting*, which brought to a positive review by *Cmagazine*; *Gallery Lane Cove* displayed the works in the virtual exhibition *Shelter Domestics*; *Artveine* selected the suite for the exhibition *What About Tomorrow*; *TERA*, *Magazine for Technologies, Ecologies and Risk Assemblages*, covered it in its opening issue[6].

On different occasions I was asked how the frequency of use of the selected keywords had changed with the pandemic. The usage rate of 'uncertainty' jumped from an average of a hundred per minute in January 2020 to about three hundred and fifty in March. When I tested it in May, the score was changing so rapidly that the system crashed several times. The frequency of use of the word 'emergency' has not changed much since May 2020: its variability is mainly correlated with the time of the day. When most of the w.e.i.r.d. sample is awake—the evening in Europe and afternoon in the U.S.—'emergency' appears in around three hundred tweets per minute, decreasing to about one hundred a few hours later. Since the composition of *W.E.I.R.D.* coincided with an unprecedented collective sanitary crisis and got deeply intertwined with it, the third and final movement, *Identity*, will be composed and recorded in the next months in order to explore how our relationship with each other through social media will have changed after months of exacerbated physical isolation.

The introduction of a sample of society inside the performative dynamics opens up new scenarios to explore. It might be interesting to parse the tweets with *A.I. Emotion Analysis* tools, attributing emotional values to the text and affecting the composition in much varied ways. *YouTube* might become a new source of content to analyze with speech-to-text software. Alternatively, other literary sources might be used to affect score generation and changes. The compositional approach itself might be investigated in search for a higher number of possible outcomes, incorporating probabilistic systems like *Recursive Neural Networks* or *Markov Chains,* that would allow the composition to evolve beyond the composer's initial intentions, and unpredictably evolve in close relationship with the changes in the social dynamics. Finally, the role of the musician, here frantically trying to react to the musical stimuli in a way similar to how people might get overwhelmed by social media's compulsive notifications, deserves to be further investigated. It would be interesting to explore the limits of

6 Tilting1; Tilting_2 ; Cmagazine; Shelter Domestics; What About Tomorrow; Tera issue 1

human reaction to a dynamic score by providing the player with more information than he can handle, and force him to make choices in order to get to the end of the performance: in a rather paradoxical way, an overload of instructions would return the possibility of a conscious choice.

Social fragmentation, the radicalization of change, the blurred boundaries between the public and personal dimensions, the unpredictability and indefiniteness that permeate postmodernity, all resonate within the perspective of the modern work of art as a conscious act of expansion towards a plurality of visions and possible semantic interpretations: the revolutionary awareness entitled to the modern artist is the inevitable responsibility to depict the present (Eco 1962). *W.E.I.R.D.* is in this sense an attempt to represent the liquid era we live in, its loss of geographical distances and the urge to find a place of unity and cohesion. Postmodernity is a collection of disconnected episodes: the absence of permanent social structures and durable relationships, the continuous bouncing from a state of emergency to the other and the preoccupation with precarity, all concur to the dissolution of the perceived continuity of temporal social planes (Tarkowska 2006). The inquiry inside the deceptivity of the present and on what synchronicity has become in the context of globalized communication are therefore fundamental aspects to investigate. Through *W.E.I.R.D*, I attempt to imagine a work of art capable of structurally adapting to the time being, making use of elements that exist necessarily in the 'now' and emerge from beyond the walls of the concert hall, liquid in shape and structure, yet vertically over-connected in an ubiquitous present tense.

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