Gaur egungo garaian, Adimen Artifiziala (AI) gizakiaren adimenaren gaitasunen barruan imajina zitezkeen kognizio-trebetasunen automatizaziora eramaten ari denean, eta konposizio musikalaren arloan artearen sorkuntza sintetikoa ere publiko orokorrera iristen ari denean, galdetzen dugu ea Adimen Artifizialaren eraginak musikan adierazpen artistikorako aukera berrien demokratizaziora eramango duen edo, aitzitik, kalitate musikala progresiboki gutxitzen duen tribializaziora eramango duen. Galdera honi erantzuteko, artikulu honek musika eta teknologiaren arteko dialektika historikoan zehar bidaia bat egiten du, xake bezalako diziplinetan antzeko prozesuak izan dituzten paraleloak bilatzen ditu, merezimenduaren eta emaitza artistikoaren eta faktore musikal eta ez-musikalen arteko bereiztezintasuna aztertzen du, algoritmoen eragin berria eta egungoa abangoardiako konposizio musikalean aztertzen du, egungo egile-eskubideen eta juridikoen egoera aztertzen du, eta Adimen Artifizialari buruzko hausnarketa etikoa egiten du AI tresnekin egunero lan egitearen esperientziaren bidez. Gure ondorioa da musika nagusitu behar dela, gizakia nagusitu behar delako.

Giltza-Hitzak: Musika Sorkuntza. Teknologia. Adimen Artifiziala.

En la era actual en la que la Inteligencia Artificial (IA) está conduciendo a la automatización de habilidades cognitivas que antes sólo eran imaginables dentro de las capacidades de la inteligencia humana, y en la que la generación sintética de arte en el campo de la composición musical está llegando también al gran público, nos preguntamos si el impacto de la Inteligencia Artificial en la música conducirá a una democratización de nuevas posibilidades de expresión artística o, por el contrario, resultará en una banalización que conduzca a una progresiva disminución de la calidad musical. Para abordar esta cuestión, este artículo realiza un recorrido por la dialéctica histórica entre música y tecnología, busca paralelismos en disciplinas que, como el ajedrez, han sufrido procesos similares, explora la inseparabilidad entre mérito y resultado artístico y entre factores musicales y extramusicales, analiza el impacto reciente y actual de la algorítmica en la composición musical de vanguardia, revisa el estatus legal y jurídico actual sobre la autoría musical y reflexiona éticamente sobre la Inteligencia Artificial a través de la experiencia de trabajar diariamente con herramientas de IA. Nuestra conclusión es que la música debe prevalecer, porque el ser humano debe prevalecer.

Palabras Clave: Creación musical. Tecnología. Inteligencia Artificial.

À l'heure où l'intelligence artificielle (IA) conduit à l'automatisation de compétences cognitives qui n'étaient auparavant imaginables que dans le cadre des capacités de l'intelligence humaine, et où la génération synthétique d'art dans le domaine de la composition musicale atteint également le grand public, nous nous demandons si l'impact de l'intelligence artificielle sur la musique conduira à une démocratisation de nouvelles possibilités d'expression artistique ou, au contraire, se traduira par une banalisation qui entraînera une baisse progressive de la qualité de la musique. Pour répondre à cette question, cet article entreprend un voyage à travers la dialectique historique entre la musique et la technologie, cherche des parallèles dans des disciplines telles que les échecs qui ont connu des processus similaires, explore l'inséparabilité entre le mérite et le résultat artistique et entre les facteurs musicaux et extra-musicaux, analyse l'impact récent et actuel de l'algorithmique sur la composition musicale d'avant-garde, examine le statut légal et juridique actuel concernant la paternité de la musique, et réfléchit de manière éthique sur l'intelligence artificielle à travers l'expérience du travail quotidien avec des outils d'IA. Notre conclusion est que la musique doit prévaloir, parce que l'être humain doit prévaloir.

Mots clés: Création musicale. Technologie. Intelligence artificielle.

Music & AI: Requiem or Symphony

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1. Music and technology: a dialectic history

The year is 1874 and Mussorgsky, a young 35-year-old Russian composer, is at the peak of his career. He has just premiered his masterpiece, the opera *Boris Godunov*, based on the homonymous work by Aleksandr Pushkin. As a prominent member of The Five (along with Balakirev, Borodin, Cui, and Rimsky-Korsakov), the opera, both in its inspiration and its music, is imbued with a strong Russian nationalist character, seeking its own style away from the prevailing Western canons.

However, Mussorgsky is deeply saddened. His good friend, the Russian painter Viktor Hartmann, has just passed away suddenly at the age of 39. Mussorgsky seeks to offer the best tribute he can. He decides to draw music. Or to musicalize art. This is how the piano suite *Pictures at an Exhibition* is born, where each movement is inspired by a painting or drawing by his friend.

Currently, the same concept of programmatic music is applied but in a very different way. We are no longer in Russia, but in the United States. It is no longer the work of a young 35-year-old composer; but of a group of scientists and researchers from a multinational company founded around 25 years ago, established as one of the largest companies in the world and controlling the main internet search engine. Google publishes *Music LM*[1], an Artificial Intelligence project that seeks to generate music synthetically from text inputs. One of the demonstrations they show involves taking the Wikipedia description of some of the most famous paintings in history and using that text as the prompt for the generative music model, offering the possibility to listen to Picasso's *Guernica* or Friedrich's *Wanderer above the Sea of Fog*.[2]

150 years separate both musical creations. Two completely different historical contexts. Two completely different technological contexts. Two completely different musical contexts. And yes, two seemingly different musical origins: the composition of a human composer versus the generation of an Artificial Intelligence model. But despite everything, the same powerful artistic idea: to draw music, to musicalize art. 150 years later, the subjective association remains the same.

Music appeals to significant dualities from very different realms. On one hand, it is fundamentally a physical phenomenon where sound waves of a particular melody, harmony, and rhythm are perceived by the human senses. On the other hand, its effect on people is far more profound: it connects us with moods, memories, feelings, and dreams. Additionally, human beings are capable of going even further in enjoying music through an intellectual dimension that transcends aspects that cannot be reached solely by that emotional dimension so inherent to us.

"Life without music would be a mistake." This famous quote attributed to Friedrich Nietzsche appeals to another of these dualities. Music as the highest artistic expression (creative, intelligent, and emotional) of the human being, and at the same time, music as an inherent factor of the very humanity that generates and perceives it. Just as in the realm of textual representation, it is impossible to dissociate cause and effect between intelligence and language; in the non-representative realm, the same holds true for music and artistic capacity. Music is inherent to human beings, and as such, it has been both shaped by them and a shaper of them. In this way,

[1] Agostinelli et al. (2023) MusicLM: Generating Music From Text https://arxiv.org/abs/2301.11325

[2] Agostinelli et al. (2023) MusicLM: Generating Music From Text. Examples. https://google-research.github.io/seanet/musiclm/examples/

music is born with the birth of humanity. Throughout the centuries, music has influenced and has been influenced by the historical, cultural, political, geographical, religious, and technological factors of this thrilling journey.

Music is a human construct that has no model, and it does not describe or represent; it only signifies. Music, therefore, does not possess an independent nature detached from the humanity that generates it. Instead, it draws from humanity and simultaneously nourishes it. In this way, the following examples can be understood:

- The augmented fourth interval (or diminished fifth) of three tones (for example, the tonal interval between the note F and the note B) introduces instability to the harmonic system because it presents two leading tones that must resolve in a specific way when subjected to the tonal system that rejects it. For this reason, throughout the tonal period, this tritone has been avoided (and it was not fully normalised until music after tonality, when this interval and its relationships were assimilated). This fact, which obeys exclusively to the physical harmonic principle, nevertheless led the Church in the past to prohibit this interval, considering it the *diabolus in musica*, even causing musical works for years to completely forgo the use of the note B.
- Beethoven initially dedicated his third and heroic symphony to Napoleon as the embodiment of the Enlightenment ideas of the French Revolution. However, Beethoven renounced this initial dedication due to his revulsion at Napoleon's subsequent turn to become a symbol of absolutism by proclaiming himself emperor.
- The rebellious sentiment of an entire generation was channelled 60 years ago through the music of four young men from Liverpool, becoming one of the most significant cultural icons of the 20th century.

Humanity advances music, and music advances humanity. This dialectic extends, of course, to the dimension of intelligence. Without human intelligence, music would not exist. And without music, human intelligence certainly would not be the same.

At this moment, when Artificial Intelligence directly challenges our human intelligence, music finds itself at a crossroads: are Artificial Intelligence models that generate music just another milestone in the ongoing relationship between music and technology, or do they represent an unparalleled turning point in the history of music? Will Artificial Intelligence be the author of the next great symphony for humanity, or are we witnessing the beginning of the requiem for genuine music?

As indispensable dimensions in humanity's historical journey, music and technology have mutually influenced each other.

Writing is one of those unparalleled technological milestones in history, and just as with knowledge, it has played and continues to play an essential role in music. In the mediaeval era, musical notation was done using symbols called neumes, which indicated the melody over liturgical texts. In the 11th century, the monk and musician Guido d'Arezzo invented a notation system where the pitch of the notes was fixed using lines, a precursor to the modern stave. This more advanced musical notation system allowed musicians to create more sophisticated compositions. In turn, the increasing complexity of musical creations promoted the evolution of musical notation systems. Musical innovation led to technological innovation, and vice versa. As a result of this process, music

gradually moved away from its anonymous and oral tradition towards written transmission and the consolidation of the musical composer's role. Similar to the rest of writing, the printing press played a fundamental role in this historical process, facilitating the distribution of sheet music to the general public.

A technological factor intrinsically linked to musical history has been the invention, refinement, and use of all types of musical instruments throughout all eras and places, with which to produce different kinds of sounds. Each new instrument has represented a new musical opportunity, and each new musical opportunity has brought about a change, to a greater or lesser extent, in musical standards. Some examples:

- The piano has been and remains a fundamental instrument in music. Its name is an abbreviation of pianoforte, which explicitly denotes its technological capacity to produce both soft (*piano*) and loud (*forte*) sounds.
- The saxophone literally means "sound of Sax," named after Adolphe Sax, the Belgian luthier who invented this instrument in the mid-19th century. Without its technological development, it would not have been possible to create one of the best vehicles for expressing the genre of music that emerged in the Afro-American communities of New Orleans and forever marked the music of the past century: jazz.
- The theremin was invented and patented by physicist Leon Theremin in the 1920s, becoming one of the first electronic musical instruments. It consists of two antennas to control the frequency and amplitude of the sound, allowing it to be an instrument whose performance is not dependent on direct physical contact with the performer.

Without technological development, it would not have been possible for music to reach the popular classes, a fundamental factor in the impetus of the Renaissance. Without technological development, it would not have been possible to combine music and theatre, and we would not have known opera, a genre whose birth coincides with that of the Baroque period. Without technological development, the progress that, during the Enlightenment, led to the propagation of ideals of equality and freedom and marked Classical music would not have been possible. Without technological development, the first Industrial Revolution, which found its musical counter-movement in Romanticism, would not have occurred.

Since the late 19th and early 20th centuries, music has evolved from the dominance of what is considered classical music to the dominance of what is considered popular music: Berlioz's Symphonie fantastique as a precursor to modern film scores; Wagner initiating the path of harmonic change that Bruckner, Mahler, and Richard Strauss continued; Dvořák incorporating influences from the popular music of American slaves in his New World Symphony; Manuel de Falla, Sergei Diaghilev, and Pablo Picasso collaborating in London to premiere the ballet The Three-Cornered Hat; Stravinsky being ultra-modern in Paris with his The Rite of Spring; Satie including sounds from everyday devices in his compositions; Gershwin incorporating jazz.

And jazz paved the way for rock, which in turn set the path for pop music.

In this journey (which extends to our present day and the predominant new musical genres of our time), technology has been, more than perhaps any other era, a determining factor. The microphone and speakers have changed the rules of voice projection and musical listening,

respectively. Instruments like the electric guitar, electric bass, and drums have formed the quintessential musical lineup for many bands. Music recording forever changed the way music is consumed: from live music to vinyl records and radio, from CDs to electronic devices and streaming platforms. As a result, there has been a universalization both in the consumption and interpretation of music.

The emergence of generative Artificial Intelligences, now in the field of music, promises to be the technological leap needed to achieve universalization in musical composition as well.

And here is where the debate arises: Can this universalization of music lead to its trivialization? If anyone can listen to music as and when they want, if anyone can interpret music as and when they want, and now if anyone can also generate music as and when they want, what merit lies in all of this? Is this the end of music?

2. Following the chess path

A discipline that has undergone a similar historical process and can serve as a reference to predict the evolution that awaits music is chess.

It is worth highlighting that chess presents two notable differences compared to music. The first difference relates to its nature. Chess is subject to rules, constraints, and starting conditions that are much more rigid, defined, and limited than those of music. While music does not start with absolute initial freedom, its constraints are primarily those imposed by physical reality: there are as many tones as there are audible frequencies of sound, the limits for rhythm are only those set by time and its discretization, and in general, there are no limits regarding genres, styles, structures, duration, intentionality, or character. In contrast, chess is governed by much stricter rules: a board of 64 squares, 6 types of pieces whose number and initial positions are always the same, specific allowed moves, fixed rules of play, and generally predetermined conditions regarding game pace, competition system, or game duration.

The second difference relates to their effect. Music primarily aims for an artistic outcome, with a strong subjective character: to evoke emotions above all. Chess, on the other hand, primarily aims for a competitive sporting outcome with a strong objective character: to win or lose.

However, despite these fundamental differences, both disciplines share common traits as high expressions of human intelligence and creative genius, as well as regarding the role that technology in general and Artificial Intelligence in particular can play in them.

Chess has always been strongly associated with human intelligence, from its foundational myth where the well-known legend narrates mathematical astuteness derived from a geometric progression through grains of wheat and squares on a board, to the 1972 World Championship where the duel between Fischer and Spassky was used as a perpetual metaphor for intellectual dominance between Americans and Soviets during the Cold War.

However, that paradigm of champion of human intelligence expression was threatened in the late twentieth century by the emergence of powerful computer programs used as analysis and gaming

modules. One of these supercomputers was Deep Blue, a machine developed by IBM, which challenged the reigning world champion at the time and one of the greatest chess players of all time, Kasparov. Between 1996 and 1997, a series of matches took place between the machine and the human, culminating in Deep Blue consistently defeating Kasparov.

More than 25 years have passed since then. The dominance of machines over humans in chess, which Deep Blue inaugurated, has only increased since. From the early chess computers based on brute force calculation power, capable of analysing millions of moves per minute and utilising references of existing games; to modern modules based on Artificial Intelligence neural networks and reinforcement learning like DeepMind's AlphaZero. All these systems surpass not only the average person but also overwhelmingly outperform any of the world's top players.

And yet, despite all this, interest in chess has not diminished in the slightest. On the contrary, it is currently experiencing its peak popularity (largely due to its fantastic adaptation to online play formats in the post-pandemic era). Not only that, but the level of human chess playing has also increased over this time. Magnus Carlsen is not just the best chess player of the last decade; he may well be the best in history. And to a large extent, this advancement in human play owes itself to the enormous possibilities offered by these computer modules and Artificial Intelligence systems: much more complex analysis capabilities, the opportunity for anyone to train as if competing with the best players of the moment, and inspiration from the strategies and moves used by machines.

In other words, the significant technological advancement applied to chess in recent years has resulted in a correlation that is not negative as many once feared, but directly positive both in terms of popularity and the level of play by humans. This impact has occurred not only in terms of the strong objective component in achieving victory but also in the subjective dimension of beauty in achieving it. Traditionally, the move h4 had been considered at least dubious (if not losing) for White in positions with short castling against short castling by Black. However, in recent years, this trend has changed after Magnus Carlsen began using it effectively (to achieve victory) and aesthetically (playing an attractive attacking game). Carlsen admitted that he started employing this move when analysing certain positions with the AlphaZero module, seeing that the move could make sense under strategic lines that humans had not even discovered until then.

Approximately twenty years after the showdown between Deep Blue and Kasparov, another historic encounter took place in another intellectually complex game, Go. This time, the world's best player, Lee Sedol, faced off against AlphaGo, DeepMind's Artificial Intelligence system. AlphaGo defeated Sedol in four out of the five games played. However, what was most striking was not just the machine's victory over the human, but the machine's ability to highlight the unique beauty in the human's play. In the one game Sedol won, he made a unique move at one point. This move was unexpected even for the machine itself. According to AlphaGo's own estimations, the statistical probability of such a move being made might equate to only one person on the entire planet being capable of it. That person was Lee Sedol, with a singular move. With a beautiful move.

When Deep Blue defeated Kasparov at the end of the 20th century, one of the most repeated messages was that this feat was possible because it was a system with a very specific form of intelligence: playing chess. No more and no less. An example given at that time was that Deep Blue would not be capable of adjusting its game based on the context of the match, akin to how a parent might adjust their level when playing with their child for educational purposes, or even forsaking

the ultimate goal of chess (victory) for a higher end that human intelligence can perceive beyond the intrinsic intelligence confined to the game itself (the opponent's feelings). This is intelligence about the formal system above the intelligence within the formal system. The machine had been more intelligent than the human in a very specific facet, but this was far from envisioning General Artificial Intelligence. Today, with multimodal generative models, we may be getting closer to such a scenario.

If Artificial Intelligence is enabling humans to play complex games historically linked to human intelligence, such as chess or Go, better and more beautifully, can we hope that it will also lead humans into a virtuous circle in music?

3. Music made by Artificial Intelligence

Every industrial revolution has aimed to automate certain tasks that were previously performed by humans, in order to achieve consistent, repetitive, predictable, and robust processes. Simultaneously, these revolutions aimed to free humans from these tasks, allowing them to dedicate themselves to other endeavours of supposedly higher nature. The early industrial revolutions tackled tasks primarily of a physical and mechanical nature, such as agriculture, transportation, raw material processing, and tool manufacturing.

However, today, Artificial Intelligence in general and generative models more specifically are causing a true industrial revolution in a radically different realm: that of intellectual, artistic, and imaginative creation. A dimension that until now seemed to be reserved exclusively for the highest intellectual capacities of human beings.

This circumstance is causing, among other effects, a real earthquake in our artistic conceptions, questioning some of the factors that were considered unquestionable:

- One of those factors is that of trivialization: Will it be worthwhile to listen to music whose creation lacked any merit?
- Another factor is the path that musical mastery is taking: to be able to generate music, we are transitioning from mastering the music itself to mastering the technologies capable of producing and reproducing music. The question to be asked is whether this shift must inherently be harmful or beneficial.

Humans are capable of finding value and beauty both in the merit of an action and in its outcome. Sometimes we even attribute more value to the merit than to the result itself: just as athletics remains the star Olympic discipline and continues to amaze us when a person can cover 100 metres in less than 10 seconds (despite the existence of vehicles capable of covering greater distances in less time), we still attend opera to hear a singer capable of projecting their voice throughout a venue without any other means than their vocal projection and technique (even though there are microphones and speakers).

In music, often the balance between merit and outcome intertwines naturally. We don't feel the same excitement listening to our favourite musical artist from home via a music streaming platform as we do witnessing them live. And experiencing a live performance with playback sound is not the

same as experiencing it with live sound. This distinction arises not only due to the greater merit involved but also because the musical outcome (the sensation, emotion, the music itself) is also different.

In other words, both in the dimension of musical merit and in the dimension of musical outcome, there are non-musical factors that are decisive for the subjective appreciation and valuation by people.

Let's consider an example: a person who has never received musical education, never had access to any musical instrument, is unfamiliar with both classical music and popular musical trends, and whistles a simple melody. Judging their musical merit solely by musical criteria might seem rather limited (after all, anyone can whistle, right?). But what if that same person whistled their song at dawn, enslaved from sunrise to sunset, heading to the cotton plantation without knowing if it would be the last time they would see their family, yet still whistling a song— their song— with all the feeling in their being. The musical merit judged by broader non-musical criteria is now unquestionable (could we ourselves do something like that?).

In this inseparability between merit and effect, and between musical and non-musical factors, lies the subjectivity of music. What constitutes a musical work of art is not solely the piece of music in isolation (as if it were reflected only in a score or performed in a vacuum), but also the perception that humanity, with its circumstances, has of it. At this moment, are we humans prepared to accept artistic productions generated by AI models?

Some recent studies seem to suggest that we are not yet ready for it. The following study, *Assessing Emotion and Sensitivity of AI Artwork*[3], generated an audiovisual artistic piece using Artificial Intelligence. This audiovisual content was presented to two similar populations of human viewers. One population was informed beforehand that the creation they were about to witness was generated by Artificial Intelligence, while the other population was not given this information. Despite both populations being exposed to exactly the same artistic creation, the population that knew they were viewing a work generated by Artificial Intelligence showed significantly more negative evaluation than the population that was unaware of this fact from the outset.

Once again, we find ourselves facing that inseparability between merit and outcome, and between purely artistic factors and extra-artistic factors. Like other technological developments in the past and as it has already done in other disciplines, Artificial Intelligence is on the verge of having enough capability to fully impact music generation. It is now up to humans to decide how we want to assimilate these possibilities and capabilities offered by technology.

As of now, Artificial Intelligence is capable of generating music from text descriptions. It can also continue a melody based on a given starting melody. It can adjust its creations according to guidelines on musical genre, timbre preferences, and inspiration from existing musical references.

Artificial Intelligence is not only being used in music for generative purposes. It is also enabling new tools for music production, allowing for automatic pitch correction, automatic instrumentation, or music recording editing. It can also generate automatic text descriptions of musical sources.

[3] Agudo et al. (2022) Assessing Emotion and Sensitivity of AI Artwork. https://www.researchgate.net/publication/359875839_Assessing_Emotion_and_Sensitivity_of_AI_Artwork

Moreover, Artificial Intelligence is being employed in musicology to enhance our understanding of certain musical factors. A notable example is the explanation given by a pair of researchers regarding the systematic tempo deviation apparent in Beethoven's work[4], concerning the discrepancy between the tempo indicated by the composer in his original scores and the natural tempo suggested by the work when performed. They used physical models of metronome behaviour and mathematical analysis of the data to provide an answer to this enigma.

Actual software provided by Artificial Intelligence-driven platforms like Suno or Udio are already capable of generating musical creations of higher quality than most people could achieve. Considering the rapid evolution in recent years of AI models in text generation from text or in image generation from text or other images, it is not unreasonable to expect that in a few years, the state of the art in synthetic music generation will reach levels of quality indistinguishable from those of the best human composers and musicians.

4. Musical Creation and Artificial Intelligence

Expressive Artificial Intelligence, a line of research that explores the application of AI in art, faces a crucial challenge, as there are no tasks that can be done strictly right or wrong. We are in a subjective field where the flag of freedom flies openly (Peña, 2010)[5].

If we review our musical history, we find examples of algorithmic thinking that has occasionally nurtured musical creation and systematised certain compositions. We can cite Guido d'Arezzo's *Micrologus*, a treatise dated around 1026 that linked words and music, where chapters 15 and 17 proposed a mechanism for automatically generating melodies from texts. To achieve this, syllables were mapped to various pitches and grouped into neumes separated by breaths, with a specific pitch assigned to each group.

Another example comes from the 18th century and is attributed to Mozart. In his *Musikalisches Würfelspiel* (Musical Dice Game), he proposed a system of tables where each cell was assigned a newly created measure. The composer wrote 176 measures, grouped into 16 sets of 11 measures each. By rolling a dice 16 times, the resulting measures were written down, creating a waltz with a "pleasant" sound (Cope, 1996)[6].

Can we consider these examples a collaboration between composer and "machine"? It is true that in both cases, the authors ensured that the data they fed into their algorithm would guarantee a satisfactory musical result. In the case of Guido d'Arezzo, the pitches of the neumes were arranged in such a way that the vowels created "consonant" intervals (perfect fourth and fifth). Similarly, Mozart crafted a constant harmonic progression that he maintained across the different cells, ensuring that regardless of the outcome of the dice rolls, there would always be a logical and balanced progression.

[4] Martin-Castro, A., & Ucar, U. (2020) Conductors' tempo choices shed light over Beethoven's metronome. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0243616

[5] Peña, F. (2010). Inteligencia Artificial y Arte [Monografía]. http://www.cs.upc.edu/~bejar/ia/material/trabajos/IA_y_Arte.pdf

[6] Cope, D. (1996). "Experiments in Musical Intelligence". Madison, WI: A-R Editions, Inc.

So, who is ultimately the author of the final product? Is it the composer, who created the rules of the game? The system, which executes the "commands" based on probability? Or the user, who interacts with the application to generate a sonic creation?

As we delve into the 20th century, we observe a much more palpable coexistence between Artificial Intelligence and the phenomenon of music, applicable to a wide range of environments, from classical music to more popular genres. From the concrete music movement led by Pierre Schaeffer and Pierre Henry to the research conducted by the Nord West Deutscher Rundfunk (NWDR) in Cologne on electronic music, to the spectral decomposition of sound by pioneers like the Ensemble l'Itinéraire, and a long list of schools and paradigms that have already become part of the curriculum and teaching programs of many conservatories, reflecting our most recent musical evolution. This symbiosis has created a disparity of directions that musical creation can take.

An example of this can be seen in the work of composer Iannis Xenakis. Among his repertoire, we find the use of computer-generated processes such as cellular automata, which allowed him to create large structures using very simple elements. In his orchestral work *Horos*, he structures specific sections using various cells with a probabilistic succession to which he assigned a specific pitch (specifically, the notes belonging to the Pelog scale, characteristic of Japanese gamelan). The numerical assignment of those notes allowed the automaton's programming to select which instrumental section would interpret each sound (1: brass; 2: woodwinds; 4: strings; 0: silence). The composer allowed himself certain liberties, as he reserved this process for homophonic sections (those sounds that maintain the same rhythm) and pre-controlled the range of the instruments to ensure they could play the generated notes.

On the other hand, his piece *Rebonds* for percussion is based on models derived from Markov chains to construct its discourse. The premise of this piece is grounded in a computer-generated random succession of *n* factors (rhythms and textures), where the probability of occurrence could be predicted within a specific time segment (*t*) repeated a certain number of times. This technique is especially located in the transitional and bridge sections between large thematic blocks, generating dynamics and rhythmic progressions with enriched counterpoint. The remainder of the work was left to the composer's discretion.

In both examples, we observe that computer technology has been used as a tool subordinate to the creative interests of the composer, applied in a nearly surgical manner to specific sections of the works to achieve controlled results. Once again, we appreciate this phenomenon of shared authorship: the inputs received by the machine are controlled by the aesthetic and technical needs of the creator.

In Spain, we find a truly prolific activity regarding the shared creation between artist and computer. Francisco Guerrero was one of the pioneers in applying fractals and Chaos Theory in his musical work, particularly inspired by the self-generative capability of a fractal structure, allowing him to create a musical piece from a small core (Russomano, 1997)[7]. His work *Rhea* for saxophone quartet employs some of these procedures, such as the computer design of a macrostructure based on a variable known as "seed," which is derived from a Brownian movement that designates a space to associate different musical pitches from data. The composer has the freedom to choose

[7] Russomanno, S. (1997). Sonidos y fractales en la música de Francisco Guerrero. Revista Doce Preliminares, 1, 27-43. http://www.docenotas.com/tienda/no-01-doce-notas-preliminares-ref2/

the timbral characteristics and sound density of each instrument to adapt to the results generated by the mathematical operations.

Alberto Posadas, awarded with the National Music Prize, has an extensive catalogue of works that explore a diverse range of structures, usually divided into compositional cycles. Notably, *Liturgia Fractal* (2008) is a cycle of string quartets that develops, among other elements, the idea of Brownian motion (Gutiérrez, 2012)[8]. Its first piece, *Ondulado Tiempo Sonoro*, is based on a curve generated from data inputted into a computer that creates the sonic trajectory of each instrument in the quartet (starting from the note A as the point of departure). From there, the composer develops different phase-shifting games between the instruments and generates various timbral effects using techniques such as *sul ponticello* or *sul tasto*, again at the composer's discretion.

If we delve further into the use of fractals in musical composition, it is essential to mention *FractMus*, an algorithmic composition software created by Gustavo Díaz Jerez (2012) that generates melodic material based on mathematical formulas. He himself states: "*You are the composer; FractMus is not going to create a masterpiece for you; it is not designed for that. It is much more useful to think of it as a tool that will provide you with raw material that you can later incorporate into your compositions*" (Jerez, 2012)[9]. Thus, what we find is an eminently practical tool that the user can utilise for their own compositional interests.

We can cite some applications that in recent years have allowed for the expansion of creative horizons to new levels: *GenJam (Genetic Algorithmic Jazz Jam Sessions)* is a program designed to emulate a jam session using genetic algorithms. From a predetermined harmony, the program creates structures similar to chromosomes, with the main characteristic of mutability: they can be replicated and improved through the inputs generated by the musician. The program is capable of listening to the improvisation of the performer in real time and replicating it based on the material generated and the input provided by the musician (Biles, 1994)[10].

DM-D (Designing Music) is a tool developed by composer Luis Robles that reverses the traditional approach to classical composition. In this way, the form of the piece is designed first (using the "composer" tool), creating an initial score by computer without any musical elements, to which the composer will later add their desired harmony. In a second step, the program itself invents a melodic structure and harmonic accompaniment (using the "harmonizer" tool), following the guidelines set by the author and respecting the form created by the system itself.

Enrique Hurtado, in his article *Arte y Máquinas* (2013)[11], succinctly summarises the consequences of what he calls the "mixed compositional process," a new approach to artistic creation in which the collaboration between humans and technology has opened up new perspectives and situations that challenge the traditional understanding of creation. Three fundamental ideas are highlighted:

[8] Gutiérrez, C. (2012). Alberto Posadas: un análisis sobre Ondulación Tiempo Sonoro. Academia para la nueva música. http://academiaparalanuevamusica.blogspot.com.es/2013/04/celer-gutierrezalberto posadasanalisis.html

[9] Jerez, 2012, at «gustavodiazjerez.com»

[10] Biles, J. A. (1994). GenJam: A Genetic Algorithm for Generating Jazz Solos. http://igm.rit.edu/~jabics/BilesICMC94.pdf

[11] Hurtado, E. (diciembre, 2013). Arte y máquinas. Revista Arte y políticas de identidad, 9, 104-112. http://revistas.um.es/api/article/view/191851/158541

1. The new conception of copyright.
2. Semi-randomness in sound production.
3. The change in the relationships with the audience.

AI has particularly changed the concept of originality in the artwork over the last century. The creation process can be interrupted in time (from the moment the creator programs an algorithm to when a user employs that tool), and we truly find ourselves facing a conceptual void regarding copyright that is already being addressed and developed by new legislation to adapt to these new situations.

Regarding semi-randomness, we can affirm that the results generated by computers are based on specific postulates, establishing limits to the actions of computing that ensure, to some extent, the "suitability" of the creations. In other words, AI operates within the rules set by users and creators, but those rules remain arbitrary.

But what happens with the third point? How can AI modify the new relationship with audiences? It is true that classical music has undergone a revolution since the 20th century, initiated by the avant-garde movements that paved the way for numerous trends (experimentation, sound laboratories, new sources of creation and reflection) that have not always been assimilated and accepted by the audience. Xenakis himself was a detractor of the integral serialism movement, noting that it was "excessively cerebral" music. Newly created music is often disparaged by the general public, and we find ourselves facing a palpable divide that has persisted to this day.

AI can be an effective resource to reconcile both worlds. In the Middle Ages, music had to serve the interests of religious texts, and compositions could not deviate from the canons set by liturgy. Guido d'Arezzo's algorithm ensured that his chants met those requirements and facilitated an approach to the divine. In the 18th century, salon dances were meant to be enjoyed in royal courts and provided entertainment for the noble classes with music that was balanced and easy to listen to. Mozart's dice game always guaranteed that outcome. Ultimately, it is the authors who decide how to use the tools and resources available to them, and therein lies the genius of many of the great creators in our history, which has allowed for the advancement of artistic creation.

Now we find ourselves with a powerful tool that is already beginning to demonstrate its immense capabilities. However, it remains an instrument that can be programmed, derived, and reused with goals that only the human mind can conceive. As has always been the case throughout human history, it depends on how it is used and for what purposes. Perhaps the friendship between music and machines is the path for new audiences to perceive the value and importance of the vast artistic creations being produced in recent years.

5. Challenges and opportunities: changing the status quo

The integration of Artificial Intelligence in musical creation and production not only transforms our relationship with music itself, emotions, and how we receive it, but also raises profound and complex legal questions. Both points of debate, emotion and regulation, are intrinsically linked: the cultural position we take as a society becomes highly relevant in regulating AI systems.

One of the biggest challenges in the realm of AI-generated music is copyright protection. Traditionally, copyright protects works created by humans because, in essence, an "author," according to the dictionary, is the "person who has produced a scientific, literary, or artistic work." However, if the creator is not a person but a machine, who should be considered the author? Is it the programmer, the authors of the data used to train the AI system, or the AI itself? Or should we directly consider that AI-generated music is not eligible for copyright protection?

Certainly, this is an open debate where the questions are numerous, evident, and logical, but the answers are far from clear.

In this context, it is useful to consider the analogy with photography in the 19th century when similar debates arose about authorship and rights over images captured with cameras. For a work to be protected by copyright, it must be original, an expression of talent and creative effort. When photography gained popularity, similar debates emerged about whether a photograph could be considered an original work. Initially, its purpose was merely to faithfully and durably represent what the human eye could capture. What creativity did a photograph contribute? The solution was to recognize creativity in the choice of framing, lighting, and other technical elements. Can we find a parallel to help resolve the dilemmas of Artificial Intelligence in music?

However, addressing the legal protection of music created by Artificial Intelligence requires us to go back to the beginning, even before its creation. A machine cannot create a song without prior preparation. It needs training, nourishment from existing music, and from there, it can begin its creative output. This is not so different from what was expected of musical creators over the centuries, a prerequisite of training and prior knowledge. Because a machine lacks innate talent, as some musical virtuosos might possess, it needs to learn.

Thus, the first question that arises is what is needed to teach this machine. The answer: data, lots of data. In this case, that data consists of musical works, which are often protected by copyright. The European AI Act[12] addresses this by highlighting the need to respect and protect intellectual and industrial property rights. It stipulates that providers of general-purpose AI models must maintain detailed documentation on the training process, ensuring transparency and compliance with current regulations. However, it does not provide a definitive solution to which we can adhere. It is not easy to predict when we might have one. We can look at sampling, which, even today, about 80 years after its popularisation, still raises debates about managing the copyright of original creators.

Furthermore, due to how AI systems operate, it can be complicated or even impossible to ascertain which references were considered in a new creation, especially for those who do not have a deep musical knowledge. Therefore, current agreements on musical plagiarism, according to extensive case law, may not apply in these cases because now we would be facing a recreation inspired by the most extensive musical library.

Once trained, AI can autonomously generate music, posing new questions about the use and distribution of these works. The broader question of who the author of such a work is remains unanswered, but it must also be acknowledged that its author is not typically one person:

[12] Council of the European Union. (2024) Artificial intelligence (AI) act. https://www.consilium.europa.eu/en/press/press-releases/2024/05/21/artificial-intelligence-ai-act-council-gives-final-green-light-to-the-first-worldwide-rules-on-ai/

producers, musicians, and singers are involved. The moral and economic implications are extensive and could reshape the music industry as we know it. Protecting the rights of human creators will undoubtedly be central to the path we begin to tread in this field.

The social perception of Artificial Intelligence is closely tied to concerns about its impact on current jobs and ways of life. And in the debate across various disciplines, it is common to find a common denominator: the value of human effort dedicated to accomplishing a task. This viewpoint inevitably influences how we ultimately regulate AI-generated music, reflecting both the opportunities and benefits of its inevitable application to this discipline, along with fears of dehumanising creative work and defending artistic aesthetics based on human expression.

This dilemma is not exclusive to music. Throughout history, the introduction of new technologies in various disciplines has sparked similar debates about authorship, ownership, and the value of human labour. The doubts that arose regarding photography as an art form comparable to painting have already been mentioned as an example. Over time, these doubts faded, and photography was recognized as a legitimate art form, which led to the adaptation of intellectual property laws to protect it.

Similarly, the arrival of film and radio in the late 19th century and television in the 20th century raised concerns about their impact on theatrical and literary works. Over time, these industries not only consolidated but also democratised access to art.

If we pause to think, what is happening today regarding the acceptance and reluctance surrounding the introduction of AI into our lives is not far removed from those debates opened in the past by other historical events, although this time the impact is absolute and pervasive; because in the case of cinema and radio, they offered different ways of experiencing and expressing the arts of literature and performance. However, in the case of music, such a clear difference is not as apparent, since the result will be available in an identical form: that new song created by a person and another recreated by a machine will coexist on music platforms.

This can help us anticipate what to expect. The evolution of regulation in such cases typically reflects a balance between protecting traditional societal values and embracing change. In the realm of AI-generated music, we will face a similar scenario, seeking a coexistence between human creativity and technological advancement. It is a real and current advancement, inevitable and overwhelming, a train that we must decide whether to board or prepare to (almost certainly) be run over.

6. Beyond music: some reflections from daily work with AI tools

In the current context, AI is universally perceived as a technology with unprecedented transformative potential. In order to drive this potential to real milestones that can bring a real and positive impact on human beings, the theoretical approaches and the practical experiences should be considered all in all in order to achieve a more comprehensive understanding of the real impact and capabilities of AI.

Considering a general perspective of AI, with the same rigour as the applied in the industrial applications of today, can bring a broader perspective to the debate of the generative AI models in general and to the music dimension in particular.

AI is emerging as a disruptive complement to the knowledge revolution initiated by the Internet. This revolution has facilitated significant advances in the generation, storage, computation, and transmission of information on a global scale. AI systems, by automating complex tasks and imitating human cognitive processes, consolidate these advances into ecosystems that address concrete problems with efficiency, precision, and traceability.

In our view, the convergence of the Internet and AI represents a milestone comparable in the history of knowledge creation and transmission, essential for human evolution. This progress is comparable in magnitude to historical innovations such as the creation of numbers, letters, or the printing press and obviously could not have been achieved without them. We reject pessimistic or lazy denialist approaches to AI, advocating instead for a deep immersion from the earliest possible age with a constructive and critical spirit. We assume that AI will bring substantial changes to our lives and we must actively decide whether we want to be agents of these changes or let others decide for us.

Our intention is to bring this perspective from the daily work of some of us in the development of advanced Artificial Intelligence systems. Our daily work involves defining real-world problems, designing systems capable of solving them, training, perfecting, certifying, deploying, and scaling them for use by millions of people worldwide. We want to ensure the right for people to use their real identity through AI-based solutions, valid for both the physical world and the digital world. We are part of a group of research centres and companies that share a set of priorities aligned with a common ethical framework, which legitimises and ensures that our work is carried out to enhance the dignity and quality of life of individuals. These priorities include maximising individuals' sovereignty over their personal data, as well as ensuring their security, privacy, and user experience.

Excellent results are being achieved with teenagers who, after just a few dozen hours of training, have been able to deploy AI-based applications to detect fake profiles online, offer career advice, or plan a healthy diet and exercise regimen. People who are no longer in the education system, and without prior programming knowledge, have also been trained to become programmers and find employment after six months of intensive assisted practice. These programs are also being extended to people in developing countries, with very positive outcomes.

The widespread availability of AI tools and knowledge marks a new era in the generation of wealth and knowledge. Open-source platforms, scientific documents, and technological advances are within reach of anyone with the clarity and determination to leverage them ethically and effectively, under a regulatory framework that ensures their fair and safe use.

The issue of explainability in AI systems is crucial as they are massively deployed in various applications. The opacity of algorithms, often described as a "black box," presents significant challenges in terms of understanding and accountability. The ability to explain the decisions and actions of AI systems is essential to mitigate biases, improve public trust, and enable effective oversight of their functioning.

Independent technical certification of AI systems in terms of performance, safety, privacy, and social responsibility will be fundamental for their effective adoption and regulation. Organisations like the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the European Committee for Standardization (CEN), and the Institute of Electrical and Electronics Engineers (IEEE) are leading efforts to establish standards that ensure the quality and safety of AI systems, which must be complemented by the necessary ethical and environmental certifications for responsible implementation.

The concern about the potential negative uses of AI is legitimate, given the ability of almost any tool to be used harmfully. We observe that algorithms, when offering us what we like ahead of what balances us, are significantly contributing to social polarisation. While this practice may be acceptable in entertainment and music, it can be deeply harmful in educational, political, and social contexts. If unlimited material ambition is the main driving force behind AI development, it will undoubtedly contribute to worsening human existence.

It is essential to address these risks with awareness, appropriate regulation, and, when necessary, sanctioning power. From all disciplines, especially Philosophy, Ethics, and Law, it is crucial to ensure that AI contributes significantly to achieving the United Nations Sustainable Development Goals, particularly in eradicating poverty, hunger, mitigating climate change, and promoting universal health and education.

These values that guide the development and application of AI to ensure a positive and sustainable impact on global society, should be the same values that guide the evolution of AI when applied to the music field:

- Rationalism: The use of reason and logic is inherent to these tools, which by design are based on mathematical structures that do not allow for cheating or shortcuts in their operation.
- Humanism: The contribution of an AI system to human value and dignity should be emphasised and evaluated, whether it truly seeks human emancipation and integral development or puts it at risk.
- Universalism: Moral rights and principles are universal and applicable to all people, regardless of origin or condition, and AI and software enable anyone to work from anywhere in the world on the most relevant projects.
- Empiricism: Observation and experience should be encouraged as the bases of knowledge, replacing those from unfounded authorities and traditions.
- Progress: An essential characteristic of AI is constantly modifying models to deepen strategies that lead to better results and abandon those that worsen them. This rule should apply to achieve continuous human progress through knowledge, science, and the improvement of social and political conditions.

7. Human being must prevail. Music must prevail

Rationalism, humanism, universalism, empiricism, and progress. These values do not arise from nothing. Nor are they the promise of what Artificial Intelligence brings or will bring. Just as they

were not brought out of nowhere by any specific technology in the past. On the contrary, they are values that humanity must contribute. That it must continue to contribute in this dialectical journey. Artificial Intelligence is a tool. A powerful tool that can pose both threats and opportunities. But a tool nonetheless. The prevalence of the human being remains where it has always been throughout history: in our own hands.

As the poem later turned into a song said: "Traveller, there is no path, the path is made by walking."

We are optimistic: human being will prevail. Because the path of what Artificial Intelligence holds for us does not have to be given. It is our responsibility.

We are optimistic: the music will prevail. As it always has.

This is February 3, 1959. Buddy Holly is 22 years old and is the most influential creative force in early rock and roll. The Big Bopper is 28 years old, his hit Chantilly Lace is the third most listened-to song in the United States in the last year. Ritchie Valens is 17 years old but has already been able to make the most important version of La Bamba in history, making it the first highly significant song sung in Spanish in rock and roll.

The three are cementing that new genre called rock and roll, the genre that will culminate the journey from classical music to popular music. The three are on a joint tour across the United States. And the three board the same small plane that tragically crashes in a cornfield in Iowa.

All three passengers, along with the pilot Roger Peterson, died that day. That day is known as "The Day the Music Died."

"The Day the Music Died" exemplifies that even a metaphor like the death of music was not used to refer to a musical misfortune (the disappearance of a tonality, the decline of a genre, a loss of quality according to scholars); but was reserved for a human misfortune: the death of three young people full of vitality whose music moved, moves, and will move so many others.

The human being prevails.

"The Day the Music Died" exemplifies that, even with its death, music inspires more music. Because this day was baptised as such by Don McLean in his beautiful and famous ballad *American Pie*, which sings in one of its verses: "*Do you recall what was revealed The day the music died?*"

Music prevails.

The human being needs symphonies. But also needs requiems. Needs music, and as long as it needs it, it will keep creating it. Even in the age of Artificial Intelligence.

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