

27.28 October 2021 Barcelona S+T+ARTS

Al and Music S+T+ARTS Festival











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Executive Summary



The AI and Music S+T+ARTS Festival explored the role of AI in our lives, using music as an example. Focused on learning and dissemination, as well as breaking down AI and technological concepts to better understand them. The festival brought together a host of creatives (musicians, DJs, visual artists, choreographers), engineers, and scientists, demonstrating the creative potential of AI through a varied program: an Opening Concert, 20 live shows and specially commissioned remote performances, talks and debates with 16 highlevel speakers, and two hackathons at the Universitat Politècnica de Catalunya (UPC) university.

The festival program included a diverse range of activities. Artists including Marco Mezquida, Holly Herndon, Mouse on Mars, Nabihah Iqbal and Libby Heaney, Hamill Industries and Kiani del Valle, Rob Clouth, Reiko Yamada, Franz Rosati, BotBop provided live performances. These were complemented by specially commissioned remote performances from YACHT, LP Duo (comissioned by Quantum Music, a S+T+ARTS funded project), Human Brother (Barcelona Supercomputing Center) and Hexorcismos (comissioned by Factory Berlin). In addition, a full program of talks and hackathons that explored AI and music creation in detail was held featuring artists and experts including Korai Tahiroglu, Antonio Torralba, Agoria, Luc Steels, Douglas Eck, Libby Heaney, Rebecca Fiebrink, Shelly Knotts, Jan St Werner and Nabihah Iqbal. The <u>full program can be</u> <u>viewed here.</u>

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In the months preceding the Festival, the consortium acted as a **Thinking Lab** which operated as a thinktank and catalyst for brainstorming and direction. **Key aspects and current challenges of AI and Music** were identified and discussed via a dedicated workshop and several meetings. The themes that emerged from the discussions within the Thinking Lab were **further developed** via the main instruments of the Festival: **Cocreations, Hackathons and Panels.**

The Festival commissioned three experimental cocreated shows to be presented in situ. Co-creation teams were formed by engineers and researchers from UPC and artists curated by Sónar, we wanted to show the various possibilities for using AI in live performances, we selected co-creations that each covered a different communication channel between the artists or the audience and the AI system. This meant that we explored different perception modalities using different AI technologies: **the opening concert by Marco Mezquida** explored **listening** through audio signal processing. A musical interaction loop was created in which both a pianist and an AI system were continuously listening





to each other, improvising a musical performance. The Hamill Industries & Kiani del Valle live show 'Engendered otherness' explored watching through Computer Vision. An AI system followed a dancer's choreography and used her movements and poses to drive the generation of images rendered on a video wall behind the dancer. The artist AWWZ performed a b2b dj set with AI, and explored reading through Natural Language Processing. Through Natural Language Processing. An AI DJ system played a back-to-back (b2b) DJ set along with a human DJ (AWWZ). The AI model was trained to read public comments from YouTube of tracks selected by the artist. This enabled it to estimate the sentiment and perception that each track might create when played live.

Another element of the Festival was the 'hackathons'. A "pre-hack" event and two hackathons, **one covering Live Coding and the other focused on AI and Music in Education**, were held on the 2nd, 23rd and 24th of October at UPC-BarcelonaTech premises. Among the **81 participants - representing 15 different countries -**, 10 teams reached the final presentation stage. This resulted in **6 winning teams**, three per hack, with **two outstanding winning solutions** that were **presented at the festival** in front of a live audience.

Four panels were presented as part of the festival program using an innovative format with some of the 16 high level speakers participating live and others via live stream. These sessions paid special attention to explaining the use and results of AI in the various aspects of music. The first panel, "Musicians learning Machine Learning: A friendly introduction to AI" was a specific and very successful presentation designed to introduce Al to musicians. In the other three **"Al and future music** genres", **"Make way for the new instruments!"** and **"Teaching Machines to feel like Humans"** all speakers were instructed to focus on explainability.

A strong identity was created for the AI and Music S+T+ARTS festival through a special logo and a specific website (<u>https://aimusicfestival.eu/</u>). This site generated 100K pageviews and almost 23K unique users.

A PR campaign was promoted resulting in **524 newspieces** in specialized and mass media that reached an **audience of 189million** with an economic value of **4million Euros**. This brought basic AI and Music concepts to a broader audience, using the content created for the festival.

The communication campaign, designed to reach both mass and specialised audiences, was run through the consortium members' platforms and amplified by all partners, as well as participating artists, scientists and speakers.

The **Sónar social media campaign** generated more than **23M impressions/displays** across all networks, with a unique **reach of 3.63 M users**.

The whole festival was live-streamed and reached **3.834 viewers** from more than 10 different countries. All content was uploaded as individual videos for video on demand (VOD) on the Sónar YouTube channel, reaching **87K video views** as of January 2022.



Rob Clouth presenting Zero Point, a show that explores chance, chaos, coincidence and the ephemeral, using the zero-point energy from quantum mechanics. Hall stage, 2021





Bozar presents Bot Bop, Integers and Strings, Hall Stage, 2021



Mouse On Mars 'AAI Live', Hall Stage, 2021





AI and Music S+T+ARTS festival Attendants walking from Hall Stage to Teatre Stage, 2021



Al and future music genres with Jan St. Werner, Libby Heaney, Nabihah Iqbal, Marius Miron, Auditori CCCB stage, 2021





Demo Research 3: 'Jazz as Social Machine', an initiative of the Alan Turing Institute led by Dr. Thomas Irvine, SonarHall stage, 2021



The Whole Earth Chanting, by Nabihah Iqbal and Libby Heaney, Hall Stage , 2021



Hamill Industries & Kiani del Valle 'ENGENDERED OTHERNESS. A symbiotic AI dance, ensemble', Teatre Stage, 2021





Interpreting Quantum Randomness: Concept by Reiko Yamada and Maciej Lewenstein, Teatre Stage, 2021



Franz Rosati 'Latentscape', Teatre Stage, 2021



Attendants at the Teatre Stage, 2021

The Festival Highlights



The first piece of music created with artificial intelligence dates back to 1957: The Iliac Suite for String Quartet, by Lejaren Hiller at the University of Illinois. In the following 60 years the relationship between music and AI took place in academic contexts, until very recently. Over the last 5-6 years, open source machine learning tools have been made publicly available and artists with different backgrounds have embraced them rapidly to explore their possibilities, opening up new creative territories and reaching wider audiences across different music genres, especially in popular music at its widest scope. AI is coming out of the lab and into people's lives, impacting across every facet of entertainment, culture and communication. The aim of the festival was to explore the role of these technologies in our lives using music as an example, putting the focus on learning and dissemination, and breaking down the AI concepts and how the technology works to better understand it whilst also discovering how artists are using this technology for their creative endeavors, and how AI is changing music technology. At the same time, artists challenged engineers and researchers on AI, stimulating new ways of collaboration and paving the way for technological innovations in the AI and music sector.



Holly Herndon presents Holly+ featuring Maria Arnal, Tarta Relena and Matthew Dryhurst, Teatre Stage, 2021







The opening panel, Musicians learning Machine Learning, a friendly introduction to AI with Rebecca Fiebrink, Santiago Pascual, Stefano Ferretti, Auditori CCCB Stage, 2021

2.1. Musicians learning machine learning

We wanted to remove as many obstacles as possible to ensure that the audience could both enjoy the shows of the AI and music festival and gain a better understanding of what was showcased on stage.

We started the festival with a panel session specifically designed to decode the language of AI, explaining the foundations of how artificial intelligence works and providing a glossary of its most commonly used terms.

The session was called <u>"Musicians learning machine</u> <u>learning, a friendly introduction to AI</u>" and we invited both AI generalists and AI and music specialists to explain the concepts of AI, starting by posing question 'What is AI?'. This was followed by explanations about terms such as machine learning, deep learning, types of neural networks, unsupervised and supervised learning, latent space and other key ideas in artificial intelligence.

The participants were: Dr. Rebecca Fiebrink, creator of The Wekinator, one of the first tools that appeared (2009) and enabled artists tocreate instruments, program interactions and work with machine learning; Nohemy Pereira-Vega, artificial intelligence specialist at the consulting firm NTT Data; Santi Pascual, AI and voice specialist working at Dolby; and Stefano Ferreti, professor at the Urbino University, who has conducted experiments with machine learning and music.







Teaching machines to feel like humans do with Antonio Torralba, Ioannis Patras, Luc Steels, Shelly Knotts (from left to right), Auditori CCCB, 2021

2.2. The relationship between humans and artificial intelligence: Emotions

Even though it might seem that technology was the focus of the festival, actually the focus was on the human; in order to create AI technology it's crucial to understand how humans perceive the world, how we see, how we listen, how our senses allow us to feel.

One of the highlights was the lecture by the scientist, musician and Al pioneer in Europe Luc Steels. He has been working at the intersection of artificial intelligence and music since the 1970s, founding the Sony Computer Science Laboratory in Paris, and is currently an ICREA research professor at the Institute for Evolutionary Biology (CSIC,UPF).

We asked him the question 'Can machines interpret human emotions?' He accepted the challenge and delivered a lecture exploring meaning in music (narratives, emotions, values), explaining how humans learn, and how machines are trained to interpret human emotions. He stressed that emotions are a deeply complex and nuanced network that include so many layers of meaning, which machines are still far from grasping.







Holly Herndon presents Holly+ featuring Maria Arnal, Tarta Relena and Matthew Dryhurst, Teatre Stage, 2021

2.3. How AI is enabling new musical instruments: Holly Herndon featuring Maria Arnal, Tarta Relena and Matthew Dryhurst.

One of the topics of the festival was how artificial intelligence is paving the way for a new generation of musical instruments. These instruments don't take inspiration from acoustic or electronic instruments, instead using the computational nature of artificial intelligence to create new embodied ways to perform. An example of this was showcased at the lecture performance delivered by the artist Holly Herndon, a pioneer in the use of artificial intelligence and voice. For the past five years she has been working with different artificial intelligence tools that enable her to process her vocals e enabling her to perform beyond the capabilities of her own voice and body. She teamed up with the Catalan singers Maria Arnal and vocal duo Tarta Relena, her partner Mathew Dryhurst, and the Barcelona based voice technology company Voctrolabs.

During lecture performance, the four singers used timbre transfer tools provided by Voctrolabs that allowed them to perform - in real time - songs in different languages and accents using Holly's voice. This played with concepts of identity: thanks to the AI, Holly sang in Catalan and Mathew Dryhurst sang with a female voice.

She also explored the ethical implications of artificial intelligence, especially relating to copyright and intellectual property, as well as identity and deep fakes.





Holly Herndon presents Holly+ featuring Maria Arnal, Tarta Relena and Matthew Dryhurst, Teatre Stage, 2021



Holly Herndon presents Holly+ featuring Maria Arnal, Tarta Relena and Matthew Dryhurst, Teatre Stage, 2021

3. The Co-creations



3.1. Introduction

The first objective of the Festival was "To provoke reflection and activate processes of co-creation of new applications for creators and industry professionals". Towards this goal, in the months preceding the Festival, the consortium acted as a **Thinking Lab** that, among other tasks, selected the projects that would define the AI & Music Festival co-creations.

In this context, a set of artists were contacted to provide project proposals for possible co-creations.

Those contacted ranged from artists who had already integrated artificial intelligence in their practice to those that had no previous experience with artificial intelligence, or indeed extremely limited experience with any digital technology.

The project selection process led to three co-creations being commissioned. As we wanted to show the various possibilities for using AI in live performances, we selected co-creations that each covered a different communication channel between the artists or the audience and the AI system. This meant that we explored different perception modalities using different AI technologies:

• **Listening** through audio signal processing. A musical interaction loop is created in which both a pianist and an AI system are continuously listening to each other and improvising accordingly.

• Watching through Computer Vision. An AI system follows a dancer's choreography and uses their movements and poses to drive the generation of images rendered on a video wall behind the dancer.

• **Reading:** through Natural Language Processing. An Al DJ system plays a b2b DJ along with a human DJ, using public comments from YouTube on the selected tracks to discern the sentiment, perception or feelings that these musical tracks generate for people.

The co-creation processes evolved in different ways, given the different levels of maturity of each concept, and the differing understandings of the possibilities of AI possibilities for each of the various artists. Nevertheless, there are a few aspects that were common in the evolution of the three co-creations.

As expected, the collaboration was perceived by both sides as a means to enlarge artistic possibilities. Specifically, artists viewed the AI systems as useful tools for co-creation. Moreover, engineers understood that the technologies that they are developing are much closer to a final product than initially thought, and they gained a better insight into their own Technology Readiness Level (TRL). Finally, thanks to the interaction between artists and engineers, they have identified an extraordinary amount of possibilities to further develop their projects, which remain unexplored but are considered feasible and interesting from both the artistic and technical side.

In the next section we further describe the three cocreations, focusing on the specificities of their definition and evolution, as well as on the precise technological solutions that each one adopted.





The opening concert at l'Auditori de Barcelona. Marco Mezquida "Piano and AI", 2021

3.2. Listening: Marco Mezquida "Piano and AI"

The goal of this co-creation was to develop a <u>AI and</u> <u>Music S+T+ARTS Festival inaugural concert</u> whereby a pianist and an "Artificial Intelligence player" could interact and play together.

Initially, the pianist Marco Mezquida, UPC researchers and Sónar representatives agreed to create a musical interaction loop. The piano sound was analyzed by the AI, which decided in real time how to appropriately accompany Marco, and then synthesized this accompaniment. On the other side , the pianist was able to listen to and receive inspiration from the musical contribution of the AI. As a result, the pianist's improvisation was enriched by the AI music, while the AI music was shaped by what the pianist was playing. The AI system relied on two main functions: (i) Audio signal analysis and understanding and (ii) Sound generations. A team of four people actively contributed to the creation of the AI system: Ivan Paz and Philippe Salembier from UPC, Josep Maria Comajuncosas, professor at ESMUC (Escola Superior de Música de Catalunya) and Joan Canyelles, an artist known as Shelly.

An essential part of the co-creation was done at ESMUC facilities where the team rehearsed regularly. ESMUC provided rooms with a concert grand piano and audio equipment. Recordings of the pianist were analyzed using signal processing and machine learning tools so that the AI could recognize the pianist's techniques and generate the necessary parameters to synthesize the AI music, and also create AI music that would be reactive to the sound of the piano.



The piano signal was initially analyzed to detect "onsets", which essentially correspond to the precise instants when a piano player is pressing a key. Once an onset was detected, a set of descriptors was estimated: the loudness, the audio signal envelope, the Pitch,the Mel-Frequency Cepstral Coefficients, and some Spectral Shape Descriptors. In total, each onset was characterised by more than one hundred different descriptor values. This high dimensionality descriptor vector was mapped into a 3-dimensional space, which was then used to recognize the specific playing techniques performed by the pianist.

Regarding the real time synthesis of the AI musical response, the technical team proposed 22 soundscapes that were reactive to a specific subset of parameters extracted from the piano signal. During the rehearsals, these soundscapes were discussed, refined and their reactivity was adjusted to the taste of the group. In the end, 10 soundscapes were selected for inclusion in the final concert. Soundscape activation relied on the AI recognition of the specific playing technique the pianist was actually performing.

Once a specific soundscape was activated, the audio

synthesis engines could use any of the descriptors that had been extracted in order to react to the pianist's playing. To create the final 10 soundscapes, a wide variety of synthesis approaches were used (subtractive and additive synthesis, samples and loop manipulation, granular synthesis, physical modeling, etc). The main set of piano descriptors used by the various soundscapes included the onset triggers, the loudness, the audio signal envelope, the pitch, the time interval between onsets (allowing silence detection and BPM) and the spectral centroid.

Reference:

 McInnes, L, Healy, J, UMAP: Uniform Manifold Approximation and Projection for Dimension Reduction, ArXiv e-prints 1802.03426, 2018.
 MAX/MSP, Cycling '74, <u>https://cycling74.com</u>
 Fluid Corpus Manipulation: Creative Research in Musical Mining of Large Sound/Gesture Datasets through Foundational Access to the Latest Advances of Signal Decomposition. European project: H2020-EU.1.1. Grant agreement ID: 725899. <u>https://www.flucoma.org/</u>









Engendered otherness by Hamill Industries & Kiani del Valle, Teatre Stage, 2021

3.3. Watching: Hamill Industries & Kiani del Valle 'Engendered otherness'

The show <u>"Engendered otherness: A symbiotic AI dance</u> <u>ensemble"</u> was co-created by the dancer Kiani del Valle; Anna Díaz and Pablo Barquín from the creative studio Hamill Industries; together with researchers Stefano Rosso, Martí de Castro and Javier Ruiz Hidalgo from the UPC.

The show plays with the idea of embodiment and how Kiani's movements can influence the movements of different natural species (animals and plants). An AI system follows Kiani's choreography and uses her movements and poses to drive the generation of images of such species, rendered on a video wall behind the dancer. The goal of the show is to push the limits of Kiani's human body into new territories of nature, thanks to the possibilities of AI.

During the initial rehearsals, some outputs of the AI system were shown to Kiani and discussed in the group. This allowed a two-way feedback in the creative process. We understood how Kiani's specific movements could better influence the AI generation and, in turn, the study of the synthesized images allowed Kiani to adapt her choreography to drive the AI to obtain more artistic results.

In this co-creation the AI system has two functions: (i) Video analysis of the dancer movements to detect her pose and (ii) Creation of models that can generate images of different natural species and even impossible fusions of models or unnatural instances of a given species.



For pose detection, it was decided that a computer vision system would capture Kiani's dance choreography. Kiani's pose at each instant would drive the AI image generation process to create similar images from a determined set of models. These AI models learn the most interesting visual characteristics from a given collection of specific animal and plant images. The influence of Kiani's movements on the AI generation could be very different depending on the species selected and the desired artistic effect. Furthermore, intermediate poses allowed us to explore new possibilities such as the 'impossible' fusion of the models of two different species.

Due to time constraints and computational complexity limitations, it was decided to capture Kiani's choreography beforehand during a final rehearsal. The videos obtained using cameras were then processed offline to estimate Kiani's poses and, from them, the image generation process was conditioned to follow Kiani's movements. A set of tools were developed so that the creative artists could experiment with the selection of different movements, poses, and different blendings of AI models. Then in the final performance, Kiani would follow a similar choreography while the offline AI generated images were rendered on the wall screen.

Several computer vision techniques were studied to analyze Kiani's movements and provide information of her pose and finally it was decided to use OpenPose [1]. A camera captures a frontal video of the dancer, and an algorithm generates an output of a a 2D skeleton with the position of 25 key points (ears, eyes, neck, shoulders, elbows, hands, hips, knees and feet).

The AI image generation is based on 8 different models of nature: insects, Lion's mane fungi, jellyfish, echinopsis flowers, photomicrography blue, photomicrography black, fern plants and a human body (Kiani) . Between 1000 and 3000 images were selected to represent each model and used to train the stylegan2 system [2]. After training, the AI system learned to interpret the variability of each model and was able to provide new sample images with high visual quality. Once all 8 models were trained, the creative artists selected several poses and motions to condition the generation of images.







AWWZ "b2b AI DJ", Hall Stage, 2021

3.4. Reading: Dj AWWZ performing a back-to-back DJ set with AI

The goal of this co-creation project was to create an Artificially Intelligent (AI) DJ system that could play a back-to-back (b2b) DJ set alongside a human DJ, AWWZ, at the AI and Music S+T+ARTS Festival.

A b2b DJ set is a collaborative DJ set, where two DJs play tracks, alternating the selection between them. This creates a dynamic setting, where each DJ bases their decisions not only on their perception of the feelings of the audience and their previous track selection, but also on the selection of the other DJ. For the AI DJ system, we used public comments from YouTube on the selected track-list as a proxy for the audience's feelings and encoded them, using a pre-trained Language Model, to "understand" the language. A central and innovative point of this project is that the data modality the AI DJ system is using is not music but text, which makes it purely language-based and sound-agnostic.

The co-creation process started with meetings between the artist, AWWZ; the researchers from UPC; and representatives from the Festival. These meetings examined the different possibilities for the project, and established the timeframe and project requirements. After the first initial meetings, the team began working on three tasks: (a) Data scraping and cleaning, (b) AI modeling, and (c) AI-human DJ communication. The technical team was formed by two PhD researchers from UPC, Ioannis Tsiamas and Casimiro P. Carrino; a Master student and DJ, Mireia De Gracia; and a UPC professor, Marta R. Costa-Jussa. During the final stage of the project, Dimas A.





Martinez joined the team to assist with software engineering aspects.

The "Data scraping and cleaning" task was the first to be completed, where the artist provided a tracklist of 900 tracks, which were then identified on YouTube. The comments on these tracks'scraped' using automated scripts. The comments on each track were then modeled by a pre-trained language model to obtain meaningful representations in a semantic space. This means that similar comments are mapped close to each other and dissimilar ones are mapped far from each other, as measured with their cosine similarity. The team, together with AWWZ, evaluated several semantic spaces, before deciding on the hyperparameters of the AI DJ system that would lead to the optimal result. At the same time, tests were carried out for the "AI-human DJ communication" task, and a communication pipeline was established, whereby the AI DJ system uses Ableton Live3 and the human DJ uses Traktor4. The two DJ softwares are linked together, withPyLive5 used to control Ableton Live3 with Python.

After the completion of the three previous tasks, rehearsals for the b2b DJ set were carried out. During the team coordination meetings, we established some additional restrictions to the AI DJ system, aimed at ensuring artist diversity (avoiding repetition of the same artist) and bpm (beats-per-minute) consistency. We also allowed the artist to play tracks from outside the AI track-list by allowing the AI DJ system to base its decisions on the recent history of tracks and not only on the very last one, as was originally intended.



AWWZ "b2b AI DJ", Hall Stage, 2021

4. Expanding the Research Collaboration on AI and Music

The AI and Music S+T+ARTS Festival teamed up with two scientific research institutions based in Barcelona. The first was the Barcelona Supercomputing Center, the national supercomputing center of Spain and one of the largest high performance computing (HPC) facilities in Europe. The second was the ICFO, the Institute for Photonic Sciences, located in Castelldefels near Barcelona, and devoted to the study and science of the generation, transmission and manipulation of light in particular in context of the next generation of quantum computers.

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Both centers collaborate frequently with artists, and most recently with musicians that wanted to engage in interdisciplinary research between art and science.



Human Brother, in collaboration with the Barcelona SuperComputing Center

4. Expanding the Research Collaboration on IA and Music





Human Brother, streamed videopiece, a collaboration between Ferran Cruixent, Artur García and the Barcelona Supercomputing Center

4.1. Barcelona Supercomputing Center

In collaboration with the <u>Barcelona Supercomputing</u> <u>Center the festival presented a video piece</u> documenting a recent collaboration between the internationally renowned composer Ferran Cruixent and Artur Garcia, a key researcher at the Barcelona Supercomputing Center. The pair presented Human Brother, a work for soprano and orchestra that explores the relationship between humans and artificial intelligence.

This collaboration between one of the foremost voices in contemporary classical music and a member of the team responsible for building the BSC's first quantum computer, served as a metaphor for the creative possibilities of random probabilities. In bringing together seemingly unrelated separate worlds, it shows how art can be created from science.

While many of the shows presented at the festival used Al tools created for music making, for this specific piece tools not intended for music were used. Large amounts of audio data were processed and used to train machine learning algorithms to compose music following Ferran Cruixent's style.



Interpreting Quantum Randomness: Concept by Reiko Yamada and Maciej Lewenstein, Teatre Stage, 2021

4.2. ICFO - Institute of Photonic Sciences

Reiko Yamada is a Japanese composer and sound artist, currently resident at the ICFO, where she works in collaboration with the quantum physicist Maciej Lewenstein. Together they have developed an interdisciplinary research project that crystallised in a series of ongoing <u>performances called "Interpreting</u> <u>Quantum Randomness"</u>, which explore the inherently random and unpredictable nature of quantum physics.

The show presents the results of this research – a series of radically new timbres and frequencies, created by the application of the principles of quantum theory to music - generating an aesthetic approximation of the level of quantum randomness that exists in the natural world.

Reiko was joined on stage by the performers Angel Faraldo, Ilona Schneider, Barbara Held, Artur Majewski and Vasco Trilla.

5. The Hackathons



As part of the activities foreseen in the Festival, a "pre-hack" event and two 'hacks' took place on the 2nd, 23rd and 24th of October on UPC-Barcelona-Tech premises.

A hackathon is a gathering of international programmers who jointly work on a collaborative

project where the core task is code development in response to a defined challenge. This basic task can be complemented and aligned with cocreation processes both on and off-line. Within the AI and Music STARTS Festival 21, the proposed projects were "Education, AI and Music" and "Using AI within live coding performance".



Presentation of the outcomes of the AI and Music S+T+ARTS Festival Hackathons, Teatre Stage, 2021





The so-called "pre-hack" was conceived as an event driven by the educational community that served to share ideas and generate new initiatives based on co-creation. It took place as an 'unconference', which meant the sessions were planned in the event itself, and the participants themselves volunteered to facilitate a conversation on a topic of their choice.

The **goals** and the aligned **actions** deployed to achieve them were fourfold:

• 1. Engaging with the student community not only as audiences, but as a central element of the ideation and organization of the Festival. We targeted HE students, primarily from UPC, and then scaled to an European Level, by engaging with the Unite! Alliance students association and general board. This formal pan-European cooperation allowed us to connect with IT scholars from the 7 universities of the EU Alliance (IST-Lisbon, UPCBarcelonaTech, Politecnico di Torino, NPI Grenoble Apls, TU Darmstadt, KTH and Aalto University).

• 2. Bridging the gap with the private sector (via sponsoring) by letting private companies actively participate in both events, promoting tech transfer and enhancing the cooperation between industry and academia. This was especially important in terms of boosting the employability of the hack participants, paving the way for further editions and ensuring the sustainability of the initiative.

• 3. Connecting Secondary Education with Higher Education by running an Ideation day (the prehack") whose results would be a starting point for the programmers in the hackathons. This event gathered co-creation music teachers, AI experts, Secondary and Higher education teachers and students together for a full day.

• 4. Establishing alliances with grassroots associations, art centers and other European funded projects. Thanks to the alliances established with SokoTech and Hangar, the project expanded to reach grassroot activists, maker communities, and formal and non-formal education institutions (secondary schools, HE music conservatories), reaching out to society at large. The aforementioned goals were part of a much broader objective: creating an AI and Music Educational Community, boosting the LiveCoding experience and connecting these two groups of people.

As a short-term **outcome** of the pre-Hack, a list of co-created topics were put together, to be further developed by programmers during the 24 Hours STARTS-Hacks:

• 1. For the LiveCoding Hack presented by Everis - an NTT data company - the challenge was identified as "Using AI within live coding performance; Extend the performer possibilities/capabilities by means of AI tools".

• 2. As for the AI and Music Educational Hack presented by Ableton, the participants could either develop their own particular idea or search for solutions to the four following concerns/challenges: (i) Support for collective musical creation, (ii) Assistance on the psychological effects during live music preparation and practice, (iii) Solutions to link musical learning with other disciplines and specialities and (iv) Control of cultural bias on musical scales.

The tangible **output** of the hacks were 6 winning teams, three per hack, with two outstanding winning solutions:

Livecoding: "With the intention of making room for debate on what it means to do science and/or art, we will perform a little experiment where Artificial Intelligence (AI) agents interact with musicians in realtime, under the framework of live-coding. The agents will first learn the instructions given by the musician, and will subsequently collaborate with each other in order to create a musical piece. The question on how creation, beauty, mistakes and the lack of answers relate with each other will guide us along this journey."

Education AI and Music Hack: "We designed a two-piece project that first uses MAX and GyrOSC to convert the information of the sensors of a mobile phone into a MIDI file. Several of these files can be input into a Magenta-based AI condenser, which averages their latent space representations, and decodes them into a single output MIDI file. The resulting melody can be thought of as the average of the input of several participants."





48 participants actively contributied in the pre-hack, including AI experts, scholars, secondary school students and teachers.

Among the 81 participants - representing 15 countries - that signed up for the two hacks, 10 teams made it to the presentation of results. The organizing team that included HackUPC, a UPC student association dealing with hackathons, coordinated a multi-disciplinary jury that awarded the three most promising teams prizes according to the evaluation criteria set up in the "information package" (please see annex III).

Some of the results issued from the hackathons have been presented beyond the AI and Music Festival, and are being disseminated amongst artistic and scientific communities, for example at the 21st Edition of "IV Encuentro Internacional sobre Literatura y Ciencia" in Donostia, Spain. Moreover, in regards with the **sustainability** of the activities, several ways of channeling the knowledge, community energy and connections have been identified:

a. A second edition of the activity, funded by public-private resources.

b. Fostering cooperation at HE level, especially with ESMUC, whose teachers were active participants in both the hack and the pre-hack.

c. Reinforcing the STARTS AI and Music Educational Community as a bridge between secondary and higher education (boosting exchange of expertise and mobility of teachers and students and joined organized activities).
d. Exploring commercial exploitation of the winning solutions for each hackathon.



Presentation of the outcomes of the AI and Music S+T+ARTS Festival Hackathons, Teatre Stage, 2021

6. The Thinking Lab



The AI and Music S+T+ARTS Festival Thinking Lab was proposed as a space for debate, co-creation and experimentation with the participation of different experts (scientists, artists and practitioners from the industry) who exchange their experiences and knowledge around AI and Music. The Thinking Lab operates as a think tank, aimed at identifying the core questions, areas of work and challenges that constitute our collective artistic and scientific approach to AI and Music.



Rebecca Fiebrink (University of the Arts London) participating remotly in the "Musicians learning Machine Learning: A friendly introduction to AI" panel





The objective of the Thinking Lab was to operate as a brainstorming catalyst from where key aspects and current challenges of AI and Music were identified and discussed. Depending on their current level of maturity and complexity, such aspects and challenges were proposed to be further developed within the main instruments of the Festival: co-creations, Hackathons and Panels.

In terms of co-creations (see Section 2), the Thinking Lab commissioned the development of three experimental shows which were presented at the Festival. Cocreations were formed by teams of engineers from the UPC and artists curated by Sónar. At the hackathons, convened by the UPC community (see Section 4), the Thinking Lab proposed the testing and prototyping of new ideas, sharing the process with the audience and other communities. Finally, the Panels presented on stage and during the Festival, are the results of the previous findings and discussions that arose from the Thinking Lab.

The initial topics proposed for discussion were as follows:

- **Tools:** New composition tools, sound processing, multimodal integration and production tools for largescale use of AI in music.
- **Emotions:** A new approach to emotions and music through the lens of AI.
- **Voice:** Tools for the integration, generation and recognition of the human voice in different formats.
- **Learning:** New machine learning techniques and transfer learning between communities.
- **Business:** Business applications of AI within the music industry and especially in the area of live music.

• **Bias:** Focus on the implicit bias of AI and ML technologies applied to the music industry.

• **Engagement:** To create and build community within the festival audiences, engaging and empowering audience feedback.

During the months prior to the Festival, the Thinking Lab convened two activities where these topics were partially addressed. These both contributed to the discussions and contents of the Festival. In May 2021, as a starting point for the discussion, <u>we organized a</u> <u>kick off workshop at the UPC Auditorium</u> with three artists and three scientists who brought to the table concepts and challenges that they presented with the aim of developing basic collective knowledge and understanding of the area of discussion.

• Three artists who have made AI an integral part of their recent work: Claire L. Evans of the USA based band YACHT; Jan St. Werner, one half of the German duo Mouse on Mars; and Ivan Paz, whose work in live-coding foreshadows the use of Machine Learning in fromscratch composition.

• Three leading scientists on AI: Michaela Milano, professor of Artificial Intelligence at University of Bologna; Jordi Pons, researcher at Dolby Laboratories; and Javier Ruiz, researcher in Computer Vision at UPC.

In addition to this workshop, during the months leading up to the AI and Music S+T+ARTS Festival, the Thinking Lab had two group discussions focused on four selected areas of interest: Instruments, Voice, Emotions and Bias. Part of the conclusions and insights of these sessions fueled the contents of the Festival, specifically the Panels. Each session involvedtwo inspiring talks given by some of the participants of the Thinking Lab:

- "Al and new instruments" by Koray Tahiroğlu
- "Al and Music: Voice" by Jordi Pons
- "Al and emotion sensing" by Antonio Torralba
- "AI and bias: The whole Earth chanting" by Libby Heaney

As previously mentioned, the Thinking Lab has also contributed to the definition of the various panels presented in the Festival offer. This task included the selection of the topic of the panel and its speakers. The Thinking Lab decided to focus on four different aspects, giving special attention to explaining the use and impacts of AI relating to the various aspects of music. As mentioned in Section 1, it was decided to have a specific panel introducing AI to musicians and, in the other panels, to ask the speakers to consider this theme as a central guide for their discussions:





• <u>"Musicians learning Machine Learning: A friendly</u> <u>introduction to AI</u>": Rebecca Fiebrink (University of the Arts London), Santiago Pascual (Dolby), Stefano Ferretti (Università di Bologna), Nohemy Pereira Vega (NTT DATA).

• <u>"Al and future music genres"</u>: Libby Heaney (artist, coder, quantum physicist), Nabihah Iqbal (musician, musicologist), Jan St. Werner (Mouse on Mars), and Marius Miron (Music Technology Group -UPF).

• <u>"Make way for the new instruments!"</u>: Agoria (dj and producer), Douglas Eck (Google Magenta), Koray Tahiroglu (Aalto University), Rob Clouth (musician, visual artist and developer). • <u>"Teaching Machines to feel like Humans</u>": Antonio Torralba (MIT), Ioannis Patras (Queen Mary University of London), Luc Steels (UPF-CSIC), Shelly Knotts (artist and improviser).

The intention of the Thinking Lab is to continue its activities beyond the end of the Festival and to further contribute to generating debate, provide space for the exchange of ideas, and to identify challenges in the myriad of possibilities surrounding AI technologies and Music.



The "AI and future music genres" with Libby Heaney (artist, coder, quantum physicist), Nabihah Iqbal (musician, musicologist), Jan St. Werner (Mouse on Mars), and Marius Miron (Music Technology Group -UPF), Teatre Stage, 2021

7. The impact of the Festival



IN PERSON ATTENDANCE

Opening Concert: 653 attendants

Festival: 1.011 attendants

PR VALUE

The association with Sónar Festival was extremely beneficial to the AI and Music S+T+ARTS festival in PR terms.

With the assistance of the Sónar press department, **524 pieces of news** were published, the majority from major newspapers in Spain, alongside features in specialist international publications reaching a **total audience of 189M** (non-unique and cumulative number of TV viewers, radio listeners, and readers of newspapers, magazines & online media).

The economic valuation of this news is estimated at 4M euros, based on the cost required to obtain the same amount of media space in the form of advertising. There have recently been a series of studies that propose multiplying such estimations by three, given that the value and impact of information is much greater than that of advertising.

All above figures were provided by Rebold agency, one of the leading media monitoring organisations in Spain.

SOCIAL MEDIA LISTENING ACROSS THE SÓNAR PLATFORMS:

The AI and Music S+T+ARTS Festival has generated **1.159 Mentions** acrossTwitter, Facebook, and Instagram between September 1st and November 22nd, 2021.

These mentions have generated more **23M impressions/displays** across all networks, with a unique **reach of 3.63 M** users.

The average **impacts per unique user is 6.3**, a very good average bearing in mind that this figure is distributed across 3 months. This translates to t each user being impacted organically twice per month (on average).

Taking a look at feedback we can observe that there was no negative feedback , with **100% of the sentiment associated qualifying as neutral or positive**, a good result.

Taking a look at the topic cloud, we can see that 'sonarfestival' is the most repeated word, followed by 'Barcelona', 'Sonar', 'artificial' and 'música'. All the words are related to the content of the Festival and no negative words or unrelated words have been found, a positive result.

VOD CONTENT VIEWS

More than **87K video views** from VOD content that generated more than **6.800 hours of broadcast**.

Average time watched per user is 10.11 minutes, a good benchmark considering market standards.

The main consumer country was Spain, representing 34% of the audience, followed by Italy, USA and Portugal.

LIVE STREAMING

Opening concert: 827 viewers. 233 hours. 17 minutes per viewer

Festival: 3.007 viewers. 1352 hours. 27 minutes per viewer

Countries:

Spain 64,1% UK 4,8% USA 4,0%, Italy 3,3% Germany 3,3% Colombia 2,0%, Greece 1,7%, Mexico 1,6 France 1,6% Netherlands 1,5%





SÓNAR NEWSLETTERS

We've sent a total of **8 Newsletters** about AI and Music Festival.

Every newsletter was sent to a database containing **49.000 users**.

The **Open Rate** of these sendouts was **over 30%** (on average), which is higher than market benchmarks. That results in **more than 117.600 real impacts**.

Click rates were over 2% which is also a really high number (more than 7800 clicks in total).

TIME OUT BEST OF THE CITY AWARDS

On December 7th the AI and Music S+T+ARTS Festival was named 'Best New Event of the Year' by Time Out Spain.

Link here

DEDICATED WEBSITE

https://aimusicfestival.eu/es

The website was the central point of the campaign, all publicity campaigns redirected to this site.

Regarding website traffic, we've generated more than **100K pageviews** and almost **23K** unique users, quite good numbers, especially given thatt it's the first time we have organized this festival in Barcelona.

SÓNAR ADVERTISING CAMPAIGN

During October we held 4 active campaigns on Instagram /and Facebook.

We created a 2-step 'funnel strategy', with first campaign focused on reach and attracting attention, and a second step focused on generating conversions (sales).

We also held an independent campaign for the opening concert, a second campaign to promote the VOD content after the festival and a third campaign to promote the AI and Music Festival short documentary film.

UPC PLATFORMS

48964 total impressions / impacts with an average network engagement of 2.5%, distributed as follows

Web

1246 Visits to news related to AI & Music S + T + ARTS Festival.

Press Releases 1996 shipments with an open rate of 24.5%

Newsletter

29062 submissions with an open rate of 66% and a click rate of 1%

Twitter

9378 impressions with a commitment of 6%.

Instagram

5089 impressions with a commitment of 1.4%

Facebook 1464 impressions with a commitment of 0.5%

Telegram 729 Views



SELECTED PRESS QUOTES

TV3 - TELENOTICIAS

(news on catalan television)

"A unique experience. AI and Music is the first festival to explore the challenges of artificial intelligence in music creation. The result is exhilarating"

LA VANGUARDIA (Esteban Linés)

"(...) the festival underlined that this project is in an experimental phase, and the feeling remained that great and amazing things are yet to come"

EL PERIÓDICO

(Jordi Bianciotto)

"(..) the result was magnificent. Added to the initial surprise, which was already important, were the infinite doors that opened at every step. Although it still has a long way to go, the Artificial Madness surprised, convinced and even seduced. In the end we left (...) not only happy, but also eager to live new similar experiences, perhaps with other instruments or with larger groups"

ABC

(David Moran)

"The challenge on this occasion was the opening concert of a new festival whose backbone is the relationship/symbiosis of music and artificial intelligence. (...) A first step that left the audience, without a doubt, wanting much more"



The experience of creating and implementing the AI and Music S+T+ARTS Festival 2021 has provided us with many insights about the current relationship between Artificial Intelligence and music. In particular, much has been learned thanks to the diversity of knowledge exchange tools that were created and developed before and during the course of the Festival.







The conclusions of such an unprecedented Festival in the city of Barcelona are based on on a selection of the most relevant findings. These can be organised under three main concepts:

• 1. Al is a new, useful tool that will soon become very common and widespread ('Al is coming out of the lab and into the real world') thanks to cooperation between the various actors in the field.

• 2. These actors are already illustrating what can be obtained through AI ('Interdisciplinary collaboration and co-creation').

• 3. Making much-needed efforts to share their perspectives and further clarify the potential and feasibility of AI-based projects ('Bringing artificial intelligence to a broader general audience').

These three main concepts are useful starting points and pave the road for future drivers of innovation, situated at the crossroads between AI and Music.

Note that the previous statement introducing our conclusions is absolutely generic: it could be applied to a myriad of fields and not only music., Across the world, we can observe the impact that AI is producing in different sectors, disrupting and reshaping established ecosystems. As has been stated in the introduction of this document, the goal of the AI and Music S+T+ARTS Festival, as a project, has been to study and test these ideas within the context of Music.

AI coming out of the lab and into the real world:

Artificial intelligence is here to stay, not only in scientific research and technological development, but also as a core component of the tools that will drive music forward in the coming years. It is clear that AI is becoming an integral part of music technology and instrument design. In all likelihood the next wave of sounds and music genres will be driven and inspired by artificial intelligence.

This is a natural evolution since music (and art in general) has always been recognisable as a driver of innovation. On the one hand, music is the ideal

playground for research and technology development: ideas can be tested and showcased in a safe environment within a short period of time (typically no legal issues are involved). On the other hand, music has always been good at adopting technologies that have little (or nothing) to do with music, adapting them for use in artistic or creative ways. This explains why, beyond the generic machine learning / deep learning technologies, we have seen very specific technologies in action during the Festival: computer vision, natural language processing, sentiment analysis, etc.

In order to discuss and determine the interrelations of all these concepts from the maximum number of perspectives, the AI and Music S+T+ARTS Festival relied from the very start on the Thinking Lab, whose mandate and composition evolved with the definition of the Festival. We believe that such an instrument, at its different stages, has been paramount for the success of the Festival and that it should continue to be active now the Festival has concluded, albeit with adaptations to its composition and main objectives.

Interdisciplinary collaboration and co-creation

The first conclusion of the whole festival process is that interdisciplinary collaboration between artists, scientists and technologists is fruitful. These three fields have never been far apart, and in the 21st century are closer than ever.

During the Festival, we have seen several shows that have emerged from artists' initiatives, while following this collaborative concept. We have had the opportunity to not only see the final result of such collaborations but also , in the case of the three co-creations commissioned by the Festival, to witness their evolution.

The three co-creations commissioned by the Festival, created by collaborations between artists, scientists and engineers have proven to be very successful, and not only from the viewpoint of the audience. As previously mentioned, the collaborations allowed the artists to see AI systems as both tools they can master, and even as partners they can learn to work with. In turn, the cocreations enabled engineers to gain more realistic view of the current Tech Readiness Level (TRL) of their projects.





As for more tangible outcomes, it should be noted that the teams involved in the three co-creations are enthusiastic about continuing their projects. This could mean that they will evolve into more sophisticated shows, both artistically and technologically. In each case, these evolutions will rely on the large number of ideas that have already been thought up and which, due to time and budget constraints, were not included in the original shows. Towards this goal, the Catalan Cultural institutions are willing to support the further development of the shows and help them tour both locally and internationally. AWWZ and her AI B2B DJ Set has already been booked for two shows following the festival, and some of the shows will be performed again in the 2022 editions of Sónar in Lisbon and Barcelona. Moreover, it is also important to highlight that scientific and technical papers based on the concepts and tools developed for the creations are being drafted.

Bringing artificial intelligence to a broader general audience

The goal of the festival was to bring artificial intelligence and its current developments to a wider audience, using music both as base context and as a concrete example. The intention was to harness the ability of artists to take complex ideas and make them accessible. Again, it is through collaboration, where both artists and AI specialists break down concepts and apply technologies, that AI can be democratized, leading to a wider understanding of its applications and creative potential in Music.

The audience's response was excellent and the public engaged very positively with the activities proposed by the festival. It should be noted that the topic of artificial intelligence is a frequent topic in the current news-cycles and not always in a positive way. At the AI & Music S+T+ARTS Festival the audience came armed with positive curiosity as to the possibilities and capabilities of artificial intelligence. The Festival became a true AI & Music celebration. Part of this can be explained due to the pedagogical approach of the Festival. All participants were asked to focus their performances on, or include in them, the concepts of learning or dissemination. This manifested itself in pedagogical panels (see, for instance, <u>Musicians learning Machine Learning: A friendly</u> <u>introduction to AI</u>) as well as comprehensive descriptions of the projects (see, for instance, <u>the initial</u> <u>talk in Engendered otherness: A symbiotic AI dance</u> <u>ensemble</u>). In this regard, Holly Herndon's show deserves a special mention. It was entirely designed, from its inception, as a combined masterclass and performance. This strategy should be further analyzed as it clearly had a strong impact on the audience.

In general, we may say that, throughout the whole Festival, the audience arrived armed with curiosity. about how AI technology works. Consequently, and as a result of the activities of the Festival they left with an increased level of knowledge of human cognition and perception.







• <u>Al and Music</u> <u>S+T+ARTS festival</u> <u>website</u>



• <u>Al and Music</u> <u>S+T+ARTS festival</u> <u>Thinking Lab first</u> <u>workshop</u>



• <u>Al and Music</u> <u>S+T+ARTS festival</u> <u>video on demand</u> (shows and talks)



• <u>Al and Music</u> <u>S+T+ARTS festival</u> <u>Hackathons</u> <u>outcome</u>



• <u>Al and Music</u> <u>S+T+ARTS festival</u> <u>documentary</u>



• https://starts.eu/







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