Co-creative instruments for improvised musical interaction
Instruments co-créatifs pour l'interaction musicale improvisée

PhD Project Proposal / Projet de recherche doctorale.

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1 Context

The research proposed in this PhD takes place in the Musical Representations Team at IRCAM / STMS Lab (G. Assayag, supervisor), and the LAM team at Sorbonne University JLRA Lab (H. Genevois, co-supervisor), in the broader context of the REACH project (Raising Co-Creativity in Cyber-Human Musicianship, PI G. Assayag, repmus.ircam.fr/reach) with international connections involving EHESS (Pr M. Chemillier, Anthropology of oral knowledge), UCSD (Pr S. Dubnov, Machine learning and music information theory) as well as University of Tokyo (Pr. P. Codognet, JFLI). The research is aimed at producing a series of models, tools and creative workflows for music improvisation occuring in cyber-human settings involving human and AI agents interacting together, subjected to generative learning processes, contributing to a renewal of forms and practices in interactive mixed music and generative live electronics. It is also founded in the idea that generative agents should be grounded in some form of embodiment in physical reality, thus leading to new instruments design, and that their behavior must also be observed from a social science and cognitive point of view, in order to assess their artistic and social acceptability. This project is in harmony with the Collegium thematic line "Improvisation, apprentissage, intelligence artificielle", in particular the analysis and modelisation of improvisation, the AI generative or helper systems, and the diversity of practices and pedagogies of improvisation and oral traditions that will be at work (contemporary, jazz, non-western, etc.).

Modeling and enacting improvisation through AI algorithms has been an ongoing activity led at Ircam by Assayag and his team for a number of years, leading to a family of operational systems such as the Omax environment and his descendants that have internationally made their mark, as evidenced by the number of scientific and artistic production (more than a hundred) they generated. After this pioneering experience, a new generation is now envisioned, characterised by high musical agentivity, cognitive and social integration, and opening to mixed reality scenarios, in order to foster co-creative behaviors between human and artificial agents. Genevois is a recognized expert in digital instruments involving cyber-physical setups and interaction programming and has explored the acoustical, cognitive and engineering aspects of Digital Musical Instruments).

The types of improvisation considered here belong to one of the two categories defined by Bailey as idiomatic and non-idiomatic, which roughly correspond to regular pulse-based improvisation and free improvisation. The term "idiom" used by Bailey highlights the existence of a cultural context and a community of people sharing this idiom as they could share a language. This raises the question of considering a particular social and cultural context as well as addressing music research formally and through technology.

2 Objectives

The research objective of this inter-disciplinary project is to model and enhance co-creativity as it arises in improvised musical interactions between human and artificial agents in a spectrum of practices spanning from interacting with software agents to mixed reality involving instrumental physicality and embodiment. This involves a conception of human-machine co-improvisation founded on structuring oppositions such as : anticipation / surprise, reactivity / planification, discovery / action, purpose / conformism etc. These qualities inspired by observation of great human improvisers raise significant research challenges when it comes to master them through engineered, cognitive and machine learning approaches. Improvisation is thus at the core of this project and indeed a fundamental constituent of co- creative musicianship, as well as a fascinating anthropological lever to human interactions in general.

The outline of the research project unfolds as follows:

- Understanding, modeling, implementing music generativity and improvised interaction as a general template for symbiotic interaction between humans and digital systems (cyber-human systems);
- Creating the scientific and technological conditions for mixed reality musical systems based on the interrelation of creative agents and active control in physical systems;
- Achieving distributed co-creativity through complex temporal adaptation of creative agents in live cyber-human systems, articulated to field experiment in musical social sciences and over social networks.

Co-creative interactions between humans and machines will be studied dynamically from different perspectives (music sciences, social sciences, computer science & AI), taking advantage of the network of collaborations in REACH, in order to highlight the combined conditions under which these interactions occur, their temporal behavior, adaptive dynamics and control strategies, so as to drastically enhance their creative potential. We'll study shared creativity as an emerging process, resulting from complex interactions and multimodal, cross feed-back loops between natural and artificial actors, a process that cannot be reduced to an agent's production considered in isolation, or to a single layer of technical skill.

3 Research Strategy

We will thus put in place a research and development ecosystem allowing us to answer three central questions:

- How to augment the digital agents capacities with enhanced computational creativity, so they can develop convincing musical interactions with humans;
- How to improve hardware and software ergonomics of human-machine interaction (HMI). A good ergonomic design must take into account many factors and, among them, the context of musical performance in which the device will be used ;
- How to augment the human capacities by expanding their individual and social creative potential, through novel collaborative strategies, so they can naturally immerse themselves in complex musical schemes involving digital intelligence, instrumentality or mixed reality.

Starting from the existing pool of improvisation tools developed by the Musical Representations team at IRCAM, such as Omax, Somax2 and DICY2 as a technical background, the project will explores these two questions by developing models of creative interaction through autonomous agent architectures, deep musical structure discovery using machine learning of multi-variate signals, and musicological and field research providing human expertise through an anthropology of improvisation practices, knowledges and processes. These tools will help creative AI agents to equip themselves with minimal cognitive structures in order to be able to listen, learn and interact with other human or artificial agents through noisy and unpredictable environments. AI agents should be able to show a certain level of reflexivity on their own behavior and display different forms of creative memory at various scales and type of activations (procedural, reflex, episodic, semantic) so as to simulate the qualities of awakening (curiosity triggered by a stimulus), attention (listening to other agents), motivation (whether or not you want to learn) and initiative (decide whether to play or not). At the same time, the tools and techniques developed during the course of the research will be actively tested and investigated in artistic residencies, taking advantage from the Ircam unique artistic context, by collecting musical expertise, feed-back and use-cases from world-class artists. This will also lead to a wide number of music pieces and data sets useful for musicological analysis.

4 Outcome

The proposed research project aims at delivering two different but interleaved kinds of output, both scientific and artistic. The scientific outcome expected from this research will contribute to the pool of AI interactive models and tools freely available to musicians and researchers, opening novel paths in (co-)creativity models and architecture. On the musical side, it will open unheard possibilities for augmented music making, performing and interacting, with the chance to work on a number of different mixed media improvisations and compositions that will be integral part of the PhD work. It will also help in evaluating the esthetical and social acceptability of AI agents in music creation, as well as the integration of new augmented instruments with actual physicality implanting these AI extensions, possibly modifying the artist's and audience's relationships and disrupting their perceptual and emotional patterns.

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