Improvisation as Speculative Computing

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ABSTRACT
We develop a framework towards the characterization of reactive and interactive systems in the context of creative software supporting rewarding human-machine experiences. First principles of coexistence, mutual influence, participation, symbiosis and the maximization of diversity are addressed. The objective is to develop interactive music systems exhibiting at once coherent and unpredictable behavior. Nature itself is considered a source of boundless inspiration.

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improvisation; interaction; interface design

ACM Classification Keywords

Human-centered computing: Human computer interaction; Human-centered computing: Interaction paradigms

Our contribution suggests a comparative study of responsive and interactive systems in the context of creative coding for human-machine improvisation. Open improvisation with machines implies a number of first principles. The principle of coexistence suggests man and machine evolve in a shared biotope possibly sharing mutual objectives in a common effort. According to the principle of mutual influence, by definition, no one is in control; man and machine contribute with equal authority to the subsistence of a reciprocal playground.

A variable floating construction emerges – particular patterns materialize from the expression of internal systemic decision-making and external activation impinging on the system. We are interested in systems offering the capacity to generate at once surprising and coherent behavior. In contrast to merely responsive systems, deep interaction avoids clear one-to-one correlations between human and machine activity. Triggered responses echo human initiative while interactive systems respond autonomously. Perhaps ironically, rewarding interactivity implies autonomy i.e. on the fly creation of appropriate functionality in the face of unpredictable external challenges.

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Extended instrument models focus on generating complex, augmented morphologies in improvisation with the assumption of a clear correspondence between action and reaction. Machine improvisation based on speculative psychological models aims to reflect aspects of biological life, focusing on spontaneous implicit behavior rather than patterns of explicit design. A wide range of approaches exists between two opposite orientations: purely reactive systems and systems that offer the impression to be alive i.e. apparently equally self-sufficient and warily responsive to external context.

Notions of musical pattern underpin most reactive systems built on algorithms producing complex evolving morphologies in time. In addition, a primarily transparent causal relationship between human input and sonic result offers a ground for straightforward aesthetic appreciation. Contrastingly, interactive systems imply spontaneous behavior as a foundation of complex morphology.

Emergence of complex forms and behavior as characterized by John Holland involves three essential components – translated into the realm of music, as follows: (1) active mechanisms, musical agents containing generators generating perpetual novelty i.e. a virtually infinite number of original and unique musical statements, (2) dynamics and regularities; particular recurrent temporal structures momentarily but clearly perceptible in an evolving musical fabric and (3) hierarchical organization, agents are organized in agencies that themselves become generators at higher levels of organization [1]. Our software adopts these ideas as design guidelines in the understanding that systems should be dynamic, not merely procedural.

Dynamic interactive systems offer strong potential for surprise and anticipation, much like in jazz improvisation; improvisers negotiate in a shared framework driven by uncertainty [2]. In this light, creative software development in general can be characterized as *speculative* computing. Essentially, one implements hypothetical models of processes one

expects to yield complex rewarding (audiovisual) experiences. As the program talks back to the artist, one gets feedback on the aesthetic potential of the instigating idea – so creative programming actively supports aesthetic introspection. In other words, tentative ideas are explored in continuing fashion, through gradual specification of objec-

tives; the focus is mobile and informed by unanticipated response. Note this approach is entirely in line with the notion of free improvisation as a uniquely valued attitude, according to Steve Lacy: "...being on the brink of the unknown and being prepared for the leap (...) if through that leap you find something then it has a value which I don't think can be found in any other way." [3]

With interactive systems featuring emergent behavior, we still expect a cognitive link to appear between user activity and system output, though we avoid trivial connectivity. In practice, a continuous scale of understanding exists correlating human and system activity between two extremes; (1) the system echoes generative interpretations, aspects of a musical context provided by a human performer and (2) the system is totally autonomous and develops its own agenda. The agenda is adaptive to external influence; man and machine are seen as live partners in a common biotope. A dialog-like, conversational approach [4] sits in between; human and machine articulate statements, negotiating and exchanging musical ideas in a common temporal niche.

Previous work explores distributed agencies where agents express social affinities and genetic programming generates appropriate musical functionality on the fly [5]. A recent implementation (called *Pock*) explores a reinforcement-learning algorithm for optimizing musical intimacy in a social setting of a single human performer and one artificial musical agent. The rationale is that we aim to grow a system from scratch, avoiding predefined data structures and complex knowledge representations. The system should learn without prejudice, by gradually building a model of (an essentially unpredictable) human performer seen as a dynamic environment. Pock develops musical policies using an implicit reward function. We infer the inclination of the performer from the observation of two competing motivations: social integration and independent self-expression. For example, policies helpful in reducing the melodic distance between man and machine in case of integration are proportionally rewarded. Lists of policies are dynamically updated and adapt gracefully to external human pressure.

More recent work studies the notion of *social mediation* – how software might optimize the social climate between two performers as to maximize chances for successful performance. We track, analyze and compare changes in physiological signals (such as heartbeats) from two performing bodies and generate arrays of musical policies helpful in minimizing the behavioral gap between both performers. Then, indirect communication between the performers happens through sound, their operational connection is only informed by spontaneous perception of musical patterns. Performers link intimately in a systemic performance loop, influencing systems behavior by reciprocally adapting in a common embodied environment to real-time audio. Embodiment is key to enactment, when musical patterns induce sensory patterns in the brain in leading to physical action [6]. For example, from the viewpoint of the human performer, speculative, intuitive improvisation also implies enacted interpretation based on the ability to turn complex patterns into units that can be dealt with in terms of expressive actions. In conclusion, interactive improvisation blends ideas of introspective speculation, adaptation and, in particular, reward processing.

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