Composing with interactive music systems

The term “interactive composition” was coined by Chadabe (1984) and is the name he gave “… to a method for using performable, real-time computer music systems in composing and performing music”. According to him, it involves two steps: Creating the system and composing/performing by interacting with it. The creation and performance aspects are inherently entangled in both stages. Creating the system involves a feedback process of continuously testing and adjusting and interacting with the system in performance situations inevitably leads to ideas for further refinements. Composing, in this sense involves not only “the software that is written, the controllers that are used and the interaction that is defined” (Momeni, 1997, p. 2) but also the act of interacting with the system or playing the instrument. Thus, the traditional line dividing the roles of composer and performer (sometimes even the listener) are blurred.

An interactive music system involves one or many performers, a controller, an algorithm and a sound producing mechanism. The differences with acoustic musical instruments are many, and the performers not always have complete control over the sonic result. The controller can be anything capable of producing data, examples are a couple of sensors attached to an acoustic instrument[[1]](#footnote-1) (the hyper-flute (Quintin, 2003) or overtone violin (Overholt, 2011)), mechanisms resembling an existing instrument (Piano MIDI controllers, the EWI), graphic interfaces on screens (the reacTable (Jordá, 2005)) or videogame controllers (Kinnect or Wiimotes). The sound producing mechanism is decoupled from the physical gesture, the latter only producing data of some kind that can be mapped in a multitude of ways before being sent to the first. The mapping algorithm can involve unpredictable elements, such as parameters changing randomly, or independent agents, such as machine learning models used to classify gestures or elements triggered via machine listening. It’s in this case when the system truly becomes interactive, as it involves real-time decisions being taken by at least two agents in response to each other.

In this chapter we’ll first explore the development of some of the first interactive music systems: Chadabe’s *CEMS* and Martirano *SalMAr Construction.*  Then, we’ll explore some of the elements that help us differentiate them from traditional instruments: the controller, mapping schemes and decision-making algorithms. The latter will lead us to a discussion about machine learning, a branch of artificial intelligence that helps computers identify patterns on input data, and thus opens new kinds of meaningful human-computer interaction.

**History: earliest interactive music systems**

Algorithmic thought and generative techniques in western art music have a long and fruitful history. One of the earliest known examples is Guido d’Arezzo’s combinatorial algorithm, used to set text to music by assigning two or three sets of notes in the 12-tone scale to a particular vowel, in a very similar way to how the syllables used in the solfège system were born. This is characteristic of abstract thought in music, where sounds are conceived not only as perceptual experiences but also as elements of a grammar, to be combined in any possible way. Further examples include the 18-th century practice of musical dice games and the 20th century obsession with serialism. All kinds of techniques have been explored, from Cage’s chance use of chance and Xenakis’s stochastic music to the use of Markov chains by Hiller and Issacson and Villa-Lobos technique of drawing contours on graph paper and determining pitch.

However, it wasn’t until the 1970’s that technological developments allowed for algorithms to run independently of human agency and respond to real-time changes. Early interactive music can be traced to the work of Joel Chadabe and Salvatore Martinaro.

At the State University of New York in 1969, Joel Chadabe installed the Coordinated Electronic Music Studio (*CEMS*) System, an automated synthesizer system designed by himself and built by Robert Moog. It consisted of three modular systems: Audio (oscillators, filters, amplifiers, noise generators, etc), Control (sequencers, envelope generators, mixers, etc) and Timing (a four-digit clock and 10 decoder/delays). Some of the modules were custom built and it became the largest concentration of Moog sequencers. The idea was to build a programable system that allowed control of independent but related parameters of sound synthesis by a single source. It probably was the first system that allowed for real-time algorithmic composition.

Soon after, he started sharing control of the sonic output by using joysticks as input device for his piece *Ideas of movement at Bolton landing* (1971). Any of the audio or control modules’ output could be shaped by voltage coming from such controllers, and the system’s sequencers generated random sequences. The result ended up being interactive: the system reacted to the joystick movements in ways not entirely predictable, while the performer reacted to the system’s output and tried to shape its behavior.

Over the next decades he continued building and performing with interactive systems, starting to use digital media with his piece *solo* (1978). The system involved using antennas to sense proximity and scheduling sounds on a Synclavier using software. He could effectively conduct an improvisation of an orchestra of electronic sounds. This was in a way the conceptual complement of Theremin’s *Thereminvox.* Instead of shaping individual sounds by controlling pitch and amplitude with left and right hand respectively, he shaped a whole piece by controlling overall tempo and timbre on real-time. Pitch and amplitude of every individual sound were left to be decided algorithmically by the software.

Simultaneously to the development of *CEMS*, composer Salvatore Martirano built an instrument called *Marvil Construction* with the help of engineer James Divilbiss. This proved to be a stepping stone in the development of a more ambitious interactive music system called *SalMar Construction*, which was finished in 1972 with the help of a group of engineers and graduate students from the University of Illinois, where Martinaro was a professor. The result was a 180-kg instrument, not including twenty-four loudspeakers and four subwoofers required for audio playback and spatialization. Its interface consisted of two sections. The lower was the main panel for live performance, consisting of an array of 291 touch-sensitive switches and lights to indicate their current state. The top consisted of a patching matrix that made possible to connect digital control circuits to analog synthesis modules.

The interaction devised for the instrument was analogue to conducting four different orchestras, each one improvising a concerto-style piece with its own soloist and ensemble. *SalMar Construction* could play 73 sound sources that were divided in four “orchestras”, basically interconnected sets of sounds patched in a way that they could share information coming from the performer via the state of the touch-sensitive switches. The way such information was modified by each orchestra could also be determined by such switches, so the logic of event scheduling by the instrument was almost completely unpredictable. The performer could loosely determine the overall texture of the piece and its general timbral distribution, switching anywhere from controlling the 4 orchestras to changing the evolution of a single processes, but they always shared control of the resultant sounds with the instrument.

The composer himself became a devoted and virtuoso performer of the *SalMar Construction*. However, he clearly wasn’t the only agent responsible for the piece, he could only make educated guesses as to what sound would result. “Control was an illusion. But I was in the loop. I was trading swaps with the logic. I enabled paths. Or better, I steered.” (Chadabe, 1997). Over the years he continued refining the *SalMar,* as well as composing and performing interactive music systems, such as the *YahaSALMaMAC Orchestra*, involving a Machintosh II computer running his SAL (Sound and Logic) software, a Yamaha DX7, multiple digital synthesis modules and Zeta MIDI violin, performed by Dorothy Martirano.

Martirano concluded his *Progress Report #1* (Martirano, 1971) with a short chapter entitled “What is real time?”, consisting mostly of a series of questions concerning such topic, sometimes of a puzzling nature. He ends up with the somewhat cryptically typed answer “The best is A HEAD.”. And it indeed was, with other pieces like Lewis’ *Voyager* (1987) and Rowe’s *Martime* (1992) (to name just a couple) continuing these developments.

The next half century oversaw an exponential increase in the creation of interactive music and real-time compostion/improvisation, aided by technological breakthroughs, the development of computer programming languages and sound synthesis software, and research on algorithms for machine listening, real-time digital signal processing and audio synthesis. Furthermore, the “entry fee” has been steadily decreasing. While the first experiments required institutional backing to see the light, powerful open-source software and cheap microcontrollers are commonplace now. Few are the prerequisites nowadays beyond a certain patience and frustration tolerance: while technology can be unwieldy at times it’s still within arm’s reach. A world of possibilities has thus been open, with a myriad of artists exploring anything from software for collaborative improvisation to interactive sound art installations.

Controllers

Mapping

Constraints afordances

Murray browne

Algorithms

Composed instrument

My motivations

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Machine Learning

AI/animism

Heidegger’s Dasein

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1. Also known as hyper, extended or augmented instruments. [↑](#footnote-ref-1)