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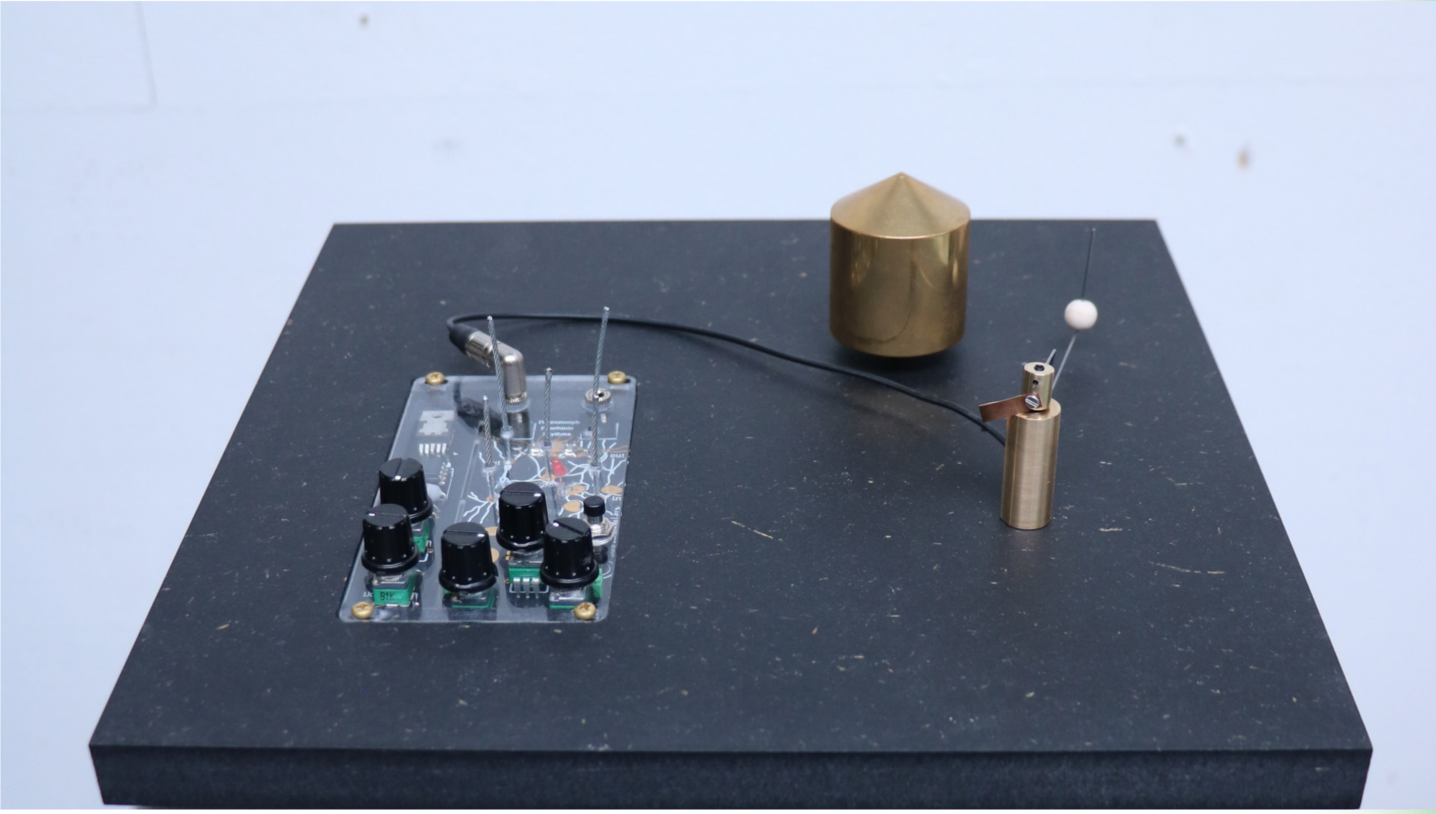
Five Robots Playing Pentatonic, Polyrhythmic Songs: 2-3-4-6-8



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Five robots playing five tuned bells by striking them with a mallet. Each robot is controlled by a minimalist, neurally inspired analogue oscillator. These oscillators are mutually connected and connected to a pacemaker oscillator, and through network connectivity, they will synchronize at different ratios with the pacemaker. Slow-running analog oscillators of the same type switch on and off the connectivity and modulate the activation of the robots' oscillators. Only through these changing network configurations a musical score emerge, that alternates between coordinated polyrhythms, random structure and moments of silence. The complex interaction between the analogue oscillators is visualized with a computer program, that graphically displays the changing relations of the oscillators as multiple x-y plots.

Description

The first documented robots and early automata were mostly self-playing music machines (Stephens and Heffernan 2016; Bruderer 2020). Through complex mechanical clockworks, gears interlocking into each other, these automata drove mallets hitting on bells or hitting on tuning forks (Chen, Ceccarelli, and Yan 2018). Later versions of musical automata encoded sequences of notes to be played on rotating cylinders, discs or punch cards. From that perspective, early musical automata may be considered predecessors for algorithmic computation.

The five robots are in this tradition, but unlike their mechanical and mechanistic predecessors, they are not bound by the rigidity of mechanical connections. They are not bound by the rigidity of digital programming either; unlike the mechanistic and deterministic execution of scripted programs, these robots are controlled by a flexible and elastic network of neurally inspired analogue oscillators. These neuromorph oscillators provide the signals to drive gearbox motors equipped with mallets that hit on tuned RIN-bells (see Fig. 1). The RIN-bells are manufactured by the Japanese instrument maker, Otsuka Factory.

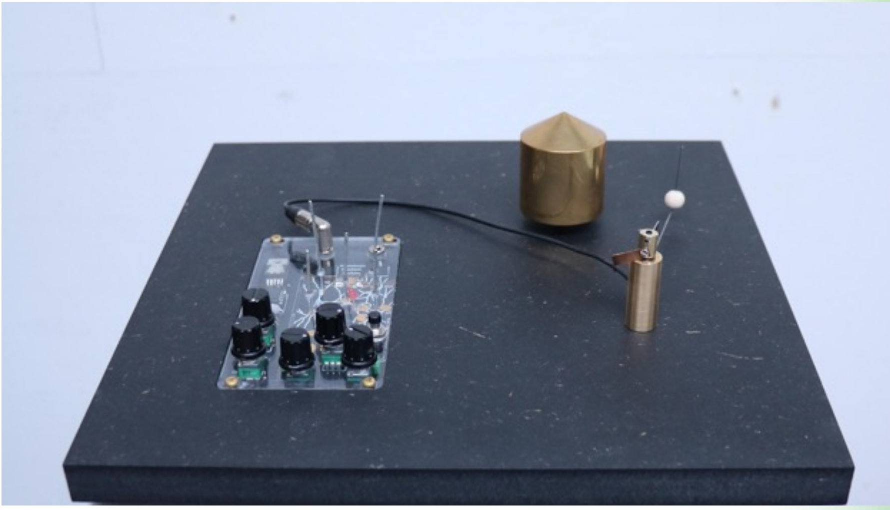


Fig. 1. One of the five robots and an oscillator circuit for hitting on a tuned bell.

Each oscillator by itself produces a beat, and the beat frequency of each oscillator is set by adjusting a variable resistor of a capacitor resistor pair. Rhythmic structures arise when these five oscillators are coupled with a network of variable resistors. In mechanical or digital setups, these structures would be hard-coded into the ratio of different gears or into the sequencing of a digital program. In the analog setup, variations are realized by having oscillators interact at different timescales: those at slower timescales modulate the connectivity of faster oscillators. How such network connectivity of simple neurally inspired oscillators can be used to create polyrhythmic structures is explained in detail in a previous paper (Faubel 2021). Here, exactly the same network topology is used: a central pacemaking oscillator connects to the five oscillators, which are all set to different frequencies, but which match up at different fractions of the pacemaker, when connected. The pacemaker is set to an approximate frequency of 240 beats per minute (bpm), the first robot is set to a frequency of 120 bpm, a fraction of two, the second robot is set to 80 bpm, a fraction of 3, the third is set to 60 bpm a fraction of 4, the forth to 40 bpm, a fraction of 6 and the fifth to 30 bpm a fraction of 8. All settings are only approximate, but when the oscillators are connected, they will go in sync with the pacemaker at the matching ratio, effectively creating the polyrhythm 2-3-4-6-8.

The installation is an adaption and continuation of a work entitled *Network Effect* that has been shown as part of the sound art exhibition *On Air Sound as Material – Material as Sound* at the Art Museum Krefeld (see Fig.2). The installation featured eight tuned bells and a table where visitors could interact with the installation by modifying the network structure. It also featured a two drawing machines and a projection visualizing the effects of network connectivity.

Fig. 2. Installation view from the previous exhibition *Network Effect* at the Art Museum Krefeld.

For xCoAx I realize a variant that will run fully autonomously without user interactions. Instead of visitors manipulating the network configuration, the installation will modify its own network structure by switching on and off small relays, that are either conducting or not, thus allowing the installation to go from a mode of connectivity where polyrhythmic structures emerge into a mode of disconnect where each robot is just following its own regime. This appearance of structure as an effect of network connectivity will be made visible through a projection of the mutual relations of oscillators driving the five robots (see Fig. 3). In addition to the connectivity, slow-running oscillators also modulate the activation of individual oscillators. A subtle influence modifies the activation of the oscillator; the robot keeps on moving but, under that influence, does not move its mallet far enough to strike the bell. As a matter of fact, sequences of silence are introduced, yet there is never a standstill but always movement within the installation, just periods without bells being stroked. The setup of the installation for xCoAx will be site-specific; the robots may be placed on one or more tables instead of pedestals. The oscillators to modulate activations and network connectivity will not be mounted on a table as in the previous installation, but instead they will be mounted into an eurorack case for modular synthesizers.

Fig. 3. Network Diagram Schematic.

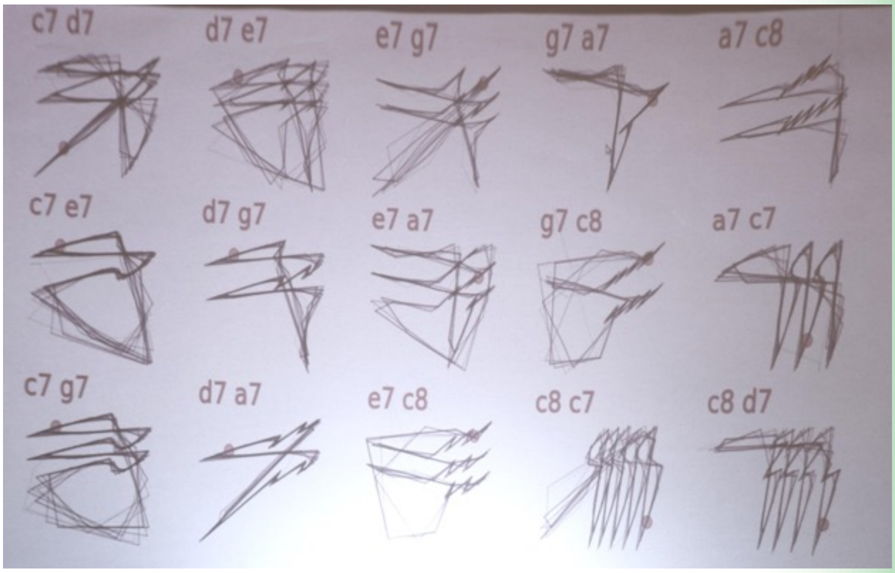


Fig. 4. A video from an experimental setup in the lab (https://vimeo.com/912950719).

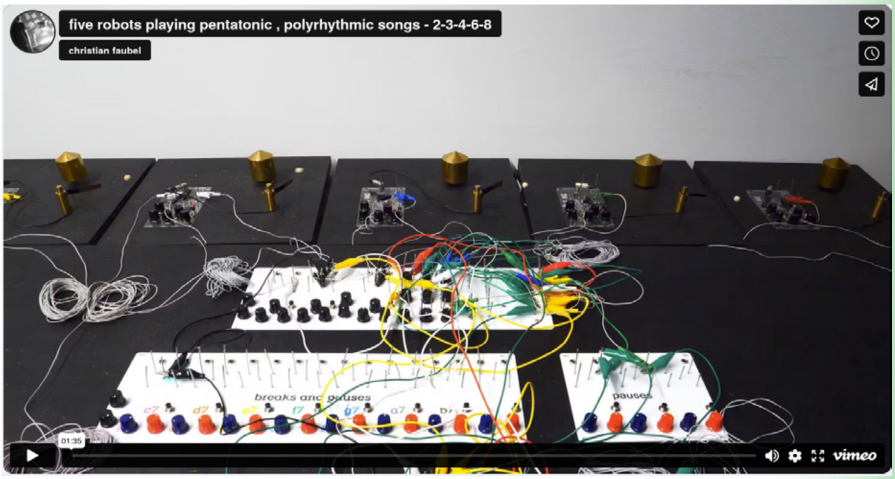
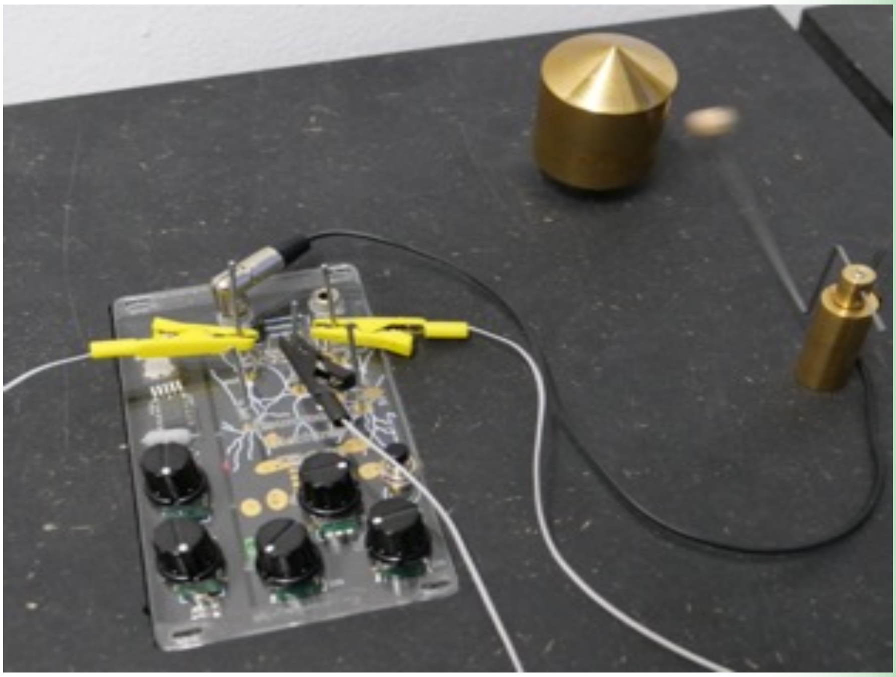


Fig. 5. Two audio examples https://soundcloud.com/fblchrstn/five-robots-playing-pentatonic-polyrhythmic-songs and https://soundcloud.com/fblchrstn/complex-coupling.



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