INSTITUTE OF SONOLOGY

Royal Conservatoire The Hague

Programming and Music 2

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Class

Course Content

The course covers **programming approaches** and the **aesthetics of contemporary computer music**.

Topics include **microsound**, **complexity**, **chaotic systems**, **generative algorithms**, **artificial intelligence**, and **live coding**.

Students will gain a solid foundation in programming and using advanced musical algorithms while dealing with contemporary computer music, the paths it makes available, its aesthetics, and the problems it introduces

Objecties

At the end of this course, you:

- Are able to **implement** and **apply** generative algorithms such as **networks**, **cellular automata** and **chaotic systems**

- Can make use of **live algorithms** and **processing** through live coding approaches

- Know how to make use of **artificial intelligence** and machine learning within a musical context

Prerequisites

An interest in d**eveloping applications** for **computer music** and related topics.

Having a good knowledge of **SuperCollider**, a computer that runs it or be willing to come to the Sonology studios to do so.

A firm knowledge of the **basics of programming** and creating application for music is a soft requirement.

Course Format

A **class** will usually focus on a specific **topic** or **theme**.

Part of the lesson will be a **presentation** of, and discussion on, the topic in question. Slides will be presented and pieces will be played.

The other part of the lesson will focus on **hands-on experimentation** in SuperCollider or any of the other featured environments.

Regular **workshops** for practical works will also take place.

Discussion and **interaction** should take place as much as possible.

If you can, bring your laptops to classes.

Assignments

An important part of the class is to **work** on the topics covered and learn how to use them in practice.

During the year there will be **three** assignments.

The assignments are concerned with **programming** aspects and **aesthetic** issues in computer music.

Topics

Topics

- (01) Microsound / Complexity -

01 - Introduction
02 - Granularity
03 - Waveforms
04 - Sonification
05 - Grammars and Fractals
06 - Chaotic Equations
07 - Object Oriented Programming
08 - Networks and Agents

Assignment 1 (30 %)

Topics

- (02) Live Coding / Transformation -

15 - SC Live Coding 1
16 - SC Live Coding 2
17 - Tidal Cycles 1
18 - Tidal Cycles 2
19 - CDP 1
20 - CDP 2
21 - Feedback
22 - Spatialisation

Assignment 2 (30 %)

Topics

- (03) Analysis / AI -

23 - Sound Analysis 1

24 - Sound Analysis 2

25 - Machine Learning 1

26 - Machine Learning 2

27 - Cellular Automata

28 - Genetic Algorithms

29 - Large Projects 1

30 - Large Projects 2

Assignment 3 (30 %)

Computer Music

Music with Computers

What is special to the making of music with computers?

* **Speed** of execution
* **Accuracy** of output
* Escape human **judgement** and **biases**
* Exploration of **formalized** ideas
* Testing of **compositional models**
* Execute tasks with **high order of magnitudes**
* Experimenting with **organizational principles**
* **Algorithmic control** for all details of a problem

“To do things that without the computer could not be done.”
(Paul Berg)

Music with Computers

What are possible **pitfalls** when making music with computers?

* Lack of **judgement** regarding its output
* Belief that an idea can **guarantee interesting results**
* **Lack of interaction** with algorithmic methods
* **Complexity problems** due to the multitude of tasks
* Lack of **possible responses** in disappointing scenarios
* Difficulties in **relating** *material*, *structure* and *form*

“When you become aware of technique, the music is failing”
(John Wall)

Possible Roles

A computer can take different roles in the creative process:

* A tool for **composition**
* Generator of **materials**
* Assistant in **organization** of materials
* **Transformation** of materials
* Interactive **partner** (in the studio or real-time)
* **Patient listener** with abilities to analyze music and performances
* **Instrument** during a performance
* **Playback device** for pre-composed materials

Representations

How the different **possibilities** of composing with computers are made available to users is a problem of **representation**.

The **possible operations** on sounds, notes, lower or higher-level structures is that what enables meaningful interaction.

With digital technology compositional methods have become reproducible due to their **digital definition** and storage.

The way materials for a composition are **represented** is certainly not something that should be thought of a being fixed. The precise definition of materials, possible operations that transform the material and relationship between them is perhaps part of what is **to be composed**.

Programming

Necessary to do anything **really new** in computer music or should be left to system designers?

Requires a perhaps slightly **different mindset** of problem solving compared to composing music?

Becomes dominant during the creative process in such a way that its **goals** become more important than the initial musical ones?

Programming and Music

Many concepts relate programming and music:

* **Hierarchy** of levels
* **Complexity** of relationships
* **Simultaneous happening** of events
* **Abstraction** of details
* **Structure** of entities
* **Modularisation** of components
* **Reference** to external ideas

Composing Sound

Music exists at **different levels** of time at any given moment.

It is common to distinguish between micro, meso and micro time but many other possible timeframes are imaginable.

*Is there a difference between **composing music** and **composing sounds?***

If a music is not based on notes, does it make sense to think of what happens beneath or above the note?

Could we think of the **sounds a music creates** instead of which music sounds create?

Parametrical thinking

A **parameter** is one of the variables that controls the outcome of a system.

Attributes of a process are converted to values representing its state where its properties and variability control the value settings.

Parametrical thinking enables limits, boundaries, parameter spaces and mapping from one to the other.

Parameter mappings include *one-to-many*, *many-to-one* and *many-to-many*.

Composition or Music Theory

In **algorithmic composition** much discussion has been on how to program software that generates “plausible” results that appear to be in a *certain style* or to *emulate a composer*.

One belief states that computers should "learn" a musical structure and then reproduce it. The idea itself prevents invention but encourages copying of ideas.

A possible confusion is between the different goals of composition on the one hand and music theory or artificial intelligence on the other.

Approaches

The working process and its different possible approaches is important both when developing software and creating music.

Two opposite poles are the *top-down approach* and the *bottom-up approach*.

The computer is an ideal tool for **inspecting** different aspects at multiple stages of the creation process.

The study of what happens during the evolution of a musical composition made with a computer can give birth to new methods and ways of making music

Ideas

Time Scales of Music

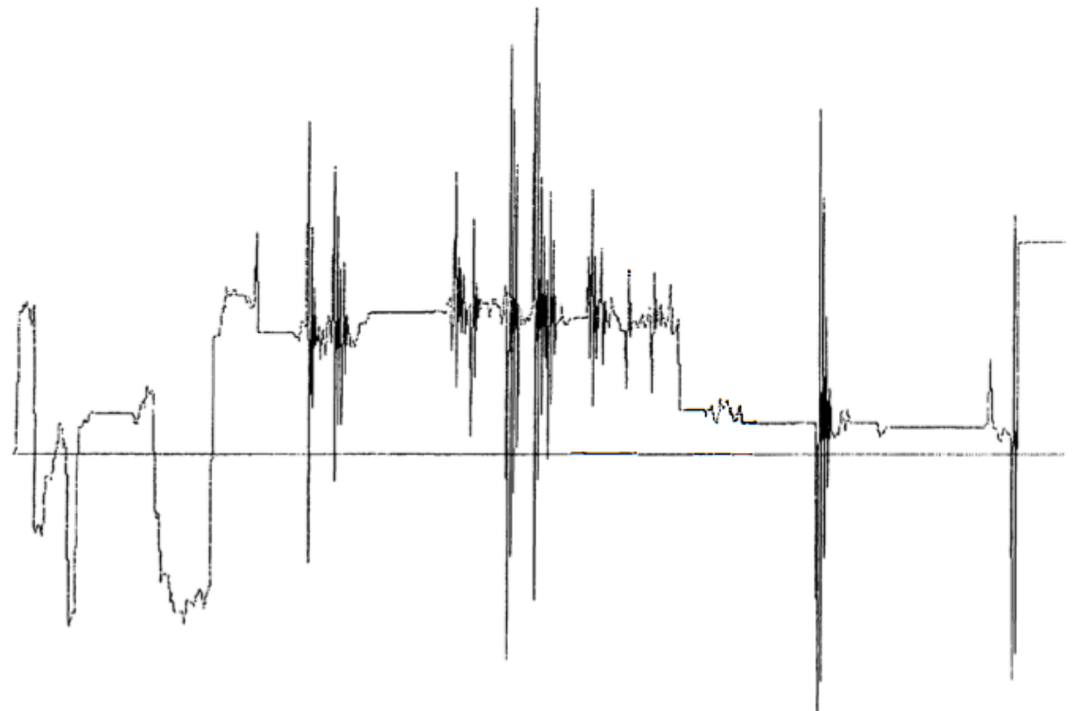
1. Infinite *(The ideal time span of mathematical durations)*
2. Supra *(beyond that of an individual composition... months, years, decades)*
3. Macro *(Overall musical architecture or form, measured in minutes or hours)*
4. Meso *(Groupings of sound objects into hierarchies of phrase structures)*
5. Sound object *(A basic unit of musical structure, generalizing the traditional note)*
6. Micro *(Particles on a time scale that extends down to the threshold of perception)*
7. Sample *(The atomic level of digital audio systems)*
8. Subsample *(Fluctuations on a time scale too brief to be properly perceived)*
9. Infinitesmall *(The ideal time span of mathematical durations)*

Curtis Roads, Microsound.

Xenakis

"*Instead of starting from the unit element concept and its tireless iteration and from the increasing irregular superposition of such iterated unit elements, we can start from a disorder concept and then introduce means that would increase or reduce it. This is like saying that we take the inverse road : We do not wish to construct a complex sound edifice by using discontinuous unit elements (bricks = sine or other functions); we wish to construct sounds with continuous variations that are not made out of unit elements. This method would use stochastic variations of the sound pressure directly.* "

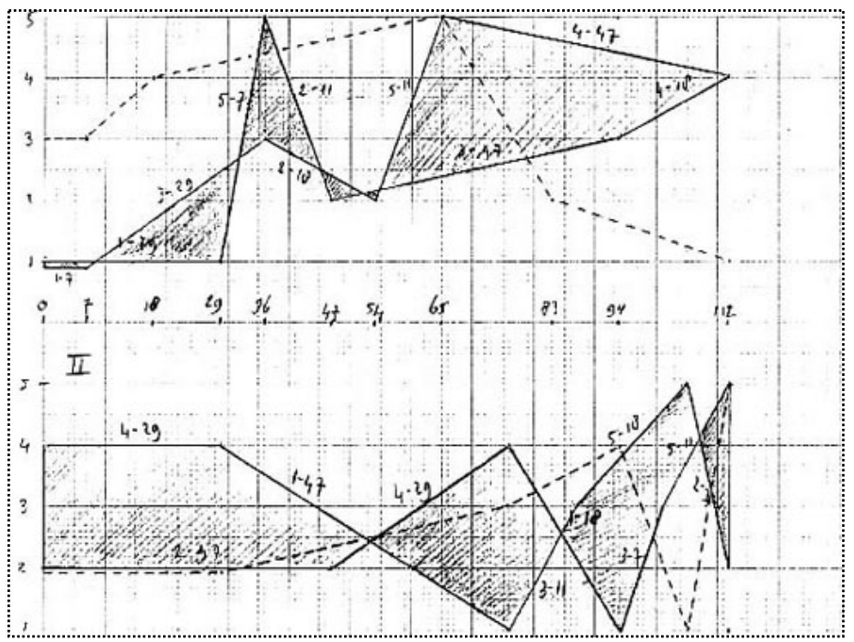
Xenakis, Formalized Music



Material

"The Cologne studio looked down on composers that "only" had form problems. "Material fetishism" dates from then and could be understood as "form fetishism". Form was not mentioned at all, everything was material; sounds as well as the serial methods. Form was seen more as an automatic consequence of the treatment of material than as an independent category to which the fashioning of sounds ought to be subordinate. When forms were exposed at all they were simple concepts such as the crossform in Kreuzpiel or the group in Gruppen, in both cases they were derived from the treatment of the material. "

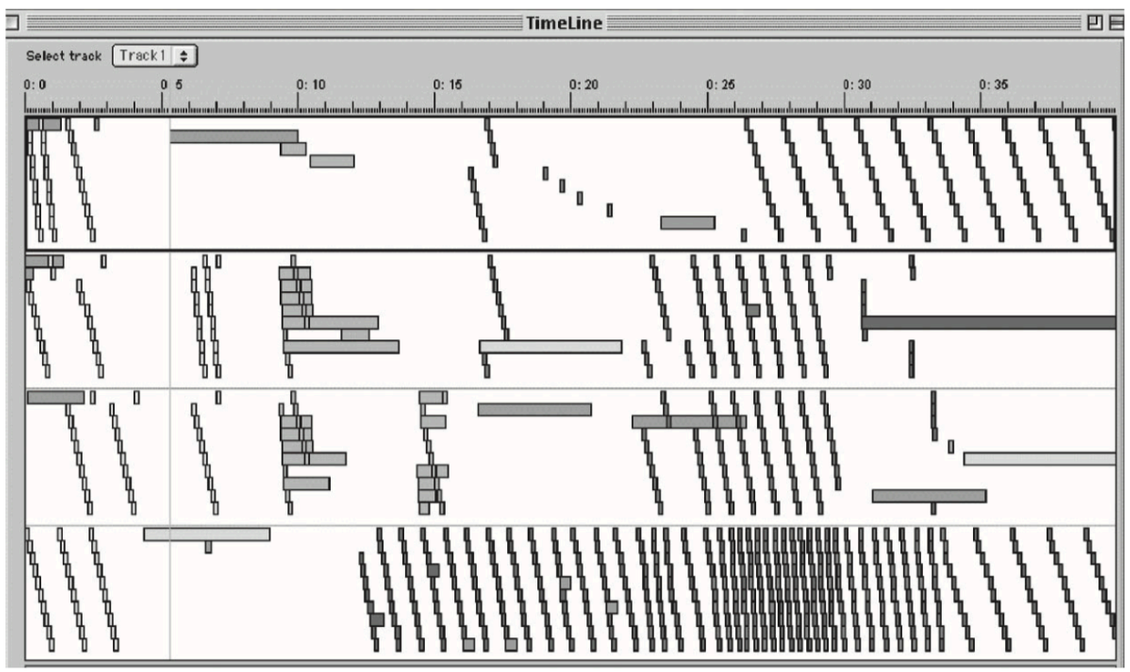
(Koenig, Genesis of Form)



Microtime

"All compositional manipulations articulating relations between different temporal levels depend essentially on the paradigm adopted by the composer. Evidently, a decision has to be made concerning the status and the nature of these interactions: to consider them as taking place in a continuum organized as a fixed hierarchy [...] or to assume the existence of discontinuities, of nonlinearities, considering (in the last case) microtime, macrotime, and all intermediate dimensions as disjoint (or relative) realms."

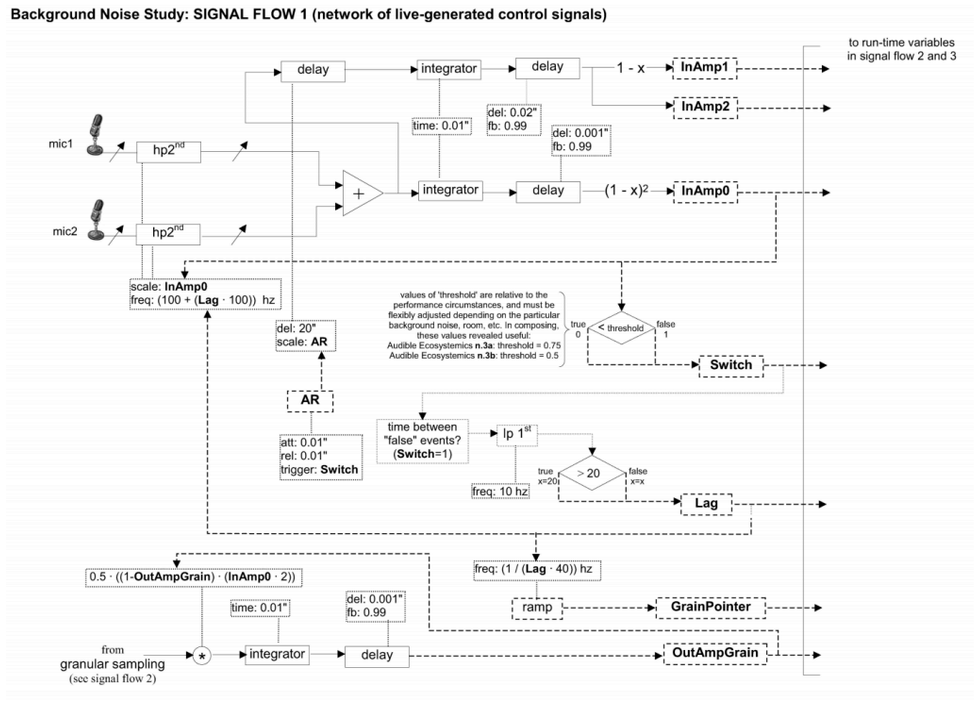
(Vaggione, interview with Budon)



Sonological Emergence

"The conceptual separation of composition (or, responsibility on premises and conditions, in my wording) and music (sonic features arising from premises and conditions) perhaps attests to a shared perspective. The implication is that sound is the epiphenomenon of a lower-level process: you design a low-level process, and the interactions and interferences among particle components taking part in the process are heard as a dynamic shape of sound, a process of sonological emergence. "

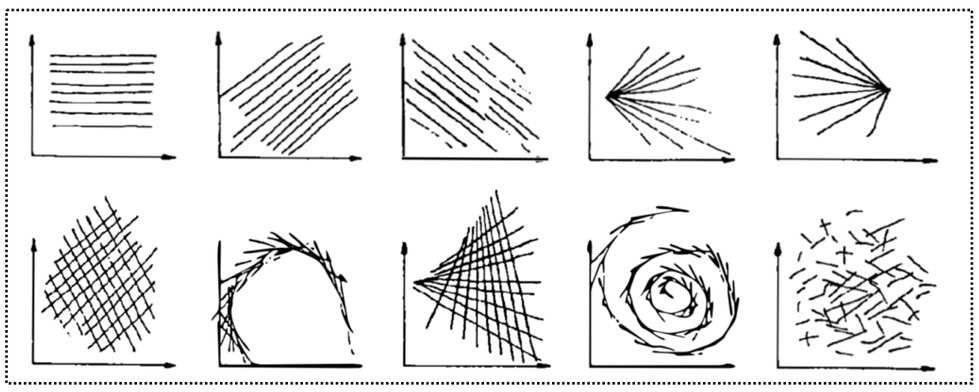
(Agostino Di Scipio, 2005)

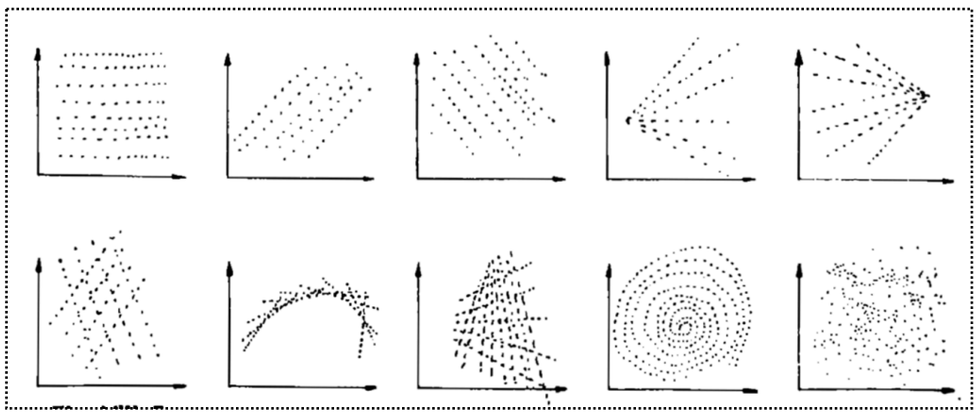


Pilot

"Freed from tedious calculations the composer is able to devote himself to the general problems that the new musical form poses and to explore the nooks and crannies of this form while modifying the values of the input data. […] With the aid of electronic computers the composer becomes a sort of pilot: he presses the buttons, introduces coordinates, and supervises the controls of a cosmic vessel sailing in the space of sound, across sonic constellations and galaxies that he could formerly glimpse only as a distant dream."

(Xenakis, Formalized Music)

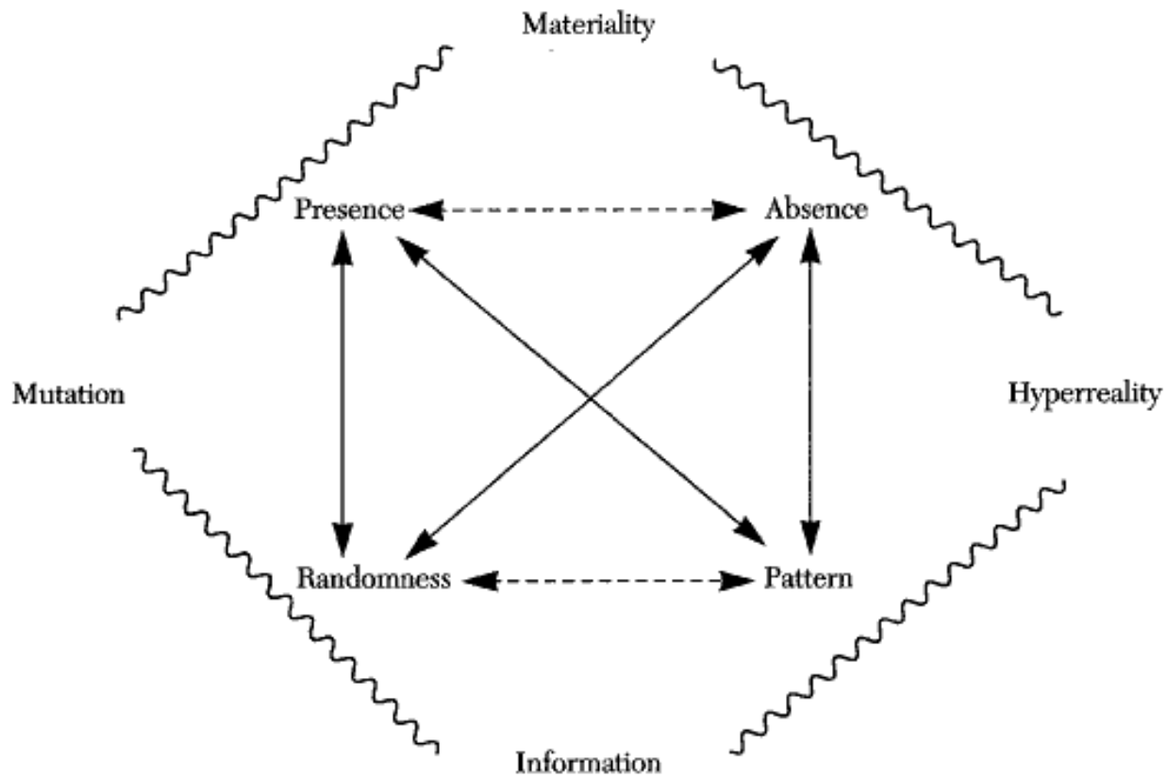




Agency

"The presumption that there is an agency, desire, or will belonging to the self and clearly distinguished from the "wills of others" is undercut in the posthuman, for the posthuman's collective heterogeneous quality implies a distributed cognition located in disparate parts that may be in only tenuous communication with one another. […] If "human essence is freedom from the wills of others," the posthuman is "post" not because it is necessarily unfree but because there is no a priori way to identify a self-will that can be clearly distinguished from an other-will."

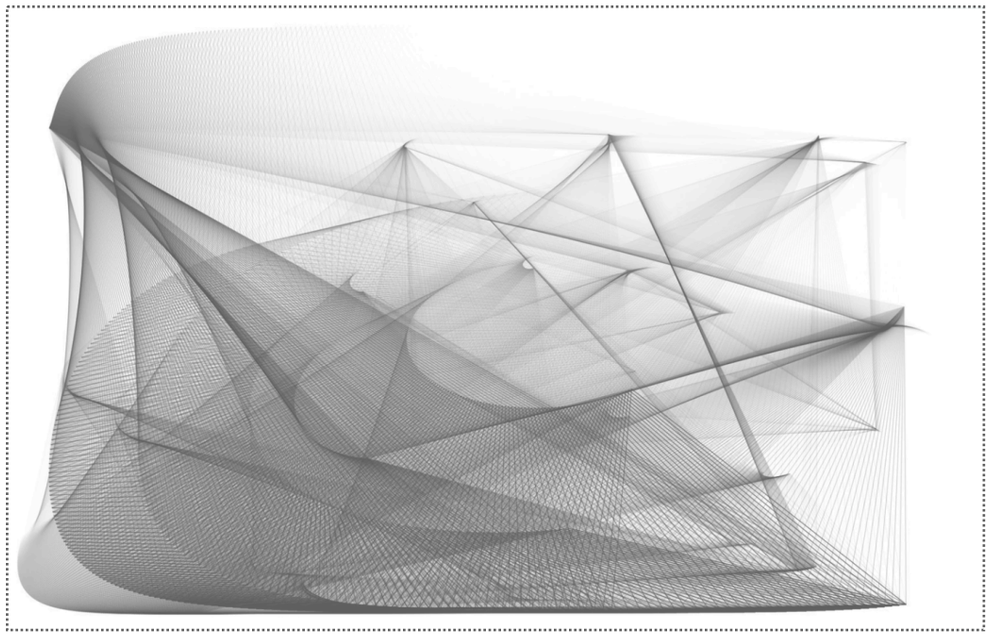
(Katherine Hayles)



Assimilation

"After the different waves of cybernetics, after information and control theory, semiotics and linguistics, cognitive science and artificial intelligence, we are reaching a point … intensified constructivism, or by a renewed realism, both of which de-emphasise the human subject and the categorial split between humans and machines.
From this standpoint, the interesting question is not so much whether machines can be creative or artistic, but rather how the exchange and assimilation processes between human and machine are structured, and how they can give rise to an aesthetics."

(Hans Holger Rutz)

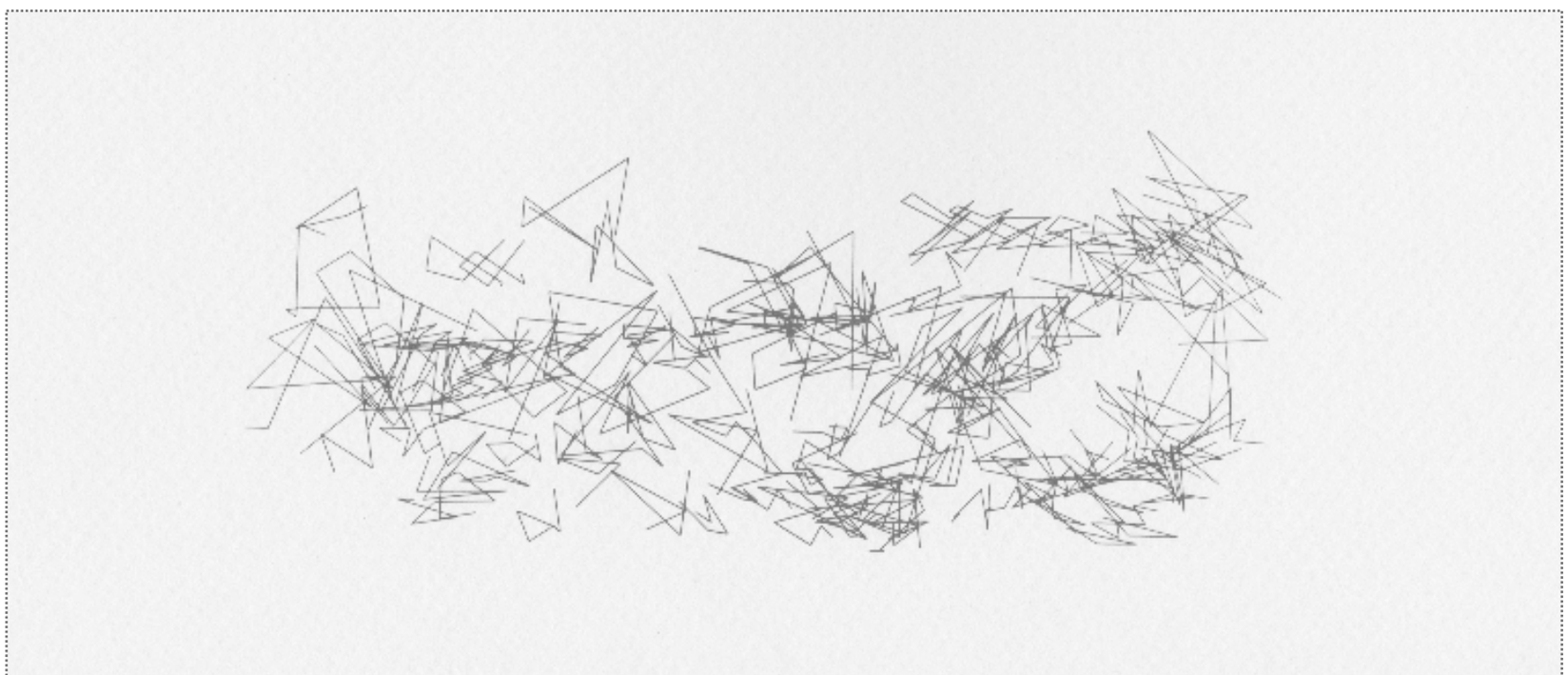


Anticommunication

"A relation between persons and things which emerges and is maintained through messages requiring and permitting not yet available encoding and decoding systems or mechanisms."

"Anticommunication is an attempt at saying something, not a refusal to say it. Communication is achievable by learning from language how to say something. Anticommunication is an attempt at respectfully teaching language to say it."

(Herbert Brün)



Contagion

"There is a concrete culture, an aesthetic and a mode of thought, specific to the computational production of new probabilities.[…] contagion is taken here to define the quasi-finitude of algorithmic objects: the fact that these objects are spatiotemporal actualities which cannot be summed up in smaller programs, and which do not result from the sum of their parts."

(Luciana Parisi)

Exercises

Exercises

1. Create two **SynthDefs** with the same parameter inputs but where each implements its own version of what impact it has. Play both in parallel using a pattern.
2. Implement **a synthesis process** where different kind of filtering is applied to low and high frequency content. **Modulate** the filters so that different movement of speeds can be perceived. Finally play the synth using a pattern and determine parameter settings using probability distributions.
3. Implement a process based on **randomness** and **simple sound synthesis** where one can start the process and leave it running without noticing obvious repetitions.