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- Between Earth and the Stars

In 1963, Xenakis envisioned the *Cosmic City*, where each tower would house 5 million inhabitants, encouraging socialization and interaction with the members of the community. Each hyperbolic paraboloid would reach more than 3000 meters high and 50 meters wide. The proposal is considered to be significant for the avant-garde urbanism projects in France throughout the 60's. Xenakis's philosophy of the city was translated as a critique towards decentralization and urban planning. Society's dynamics inspired Xenakis to conceive an above the clouds rising city, a utopia which symbolizes the urge for humanity to look towards human colonies and the universe.

-Xenakis and stochasticity

The "law of large numbers" also plays a fundamental role in Xenakis's musical composition technique. At the end of the 1950s, on the search for an objective approach to musical form, he had developed a "stochastic theory of musical composition", based on mathematical and logical laws. The music became a field of varying parameters establishing the composer as its coordinator. In addition, the form and the content of a piece derive from the rules that determine its event space. Xenakis introduced statistics into the musical field, considering it as a space of probability in order to be confronted with the complexity of such a formalization of music. Controlled indeterminism, as a catalyst for continuous variation, is a key element in his creative approach. According to the law, which played a very central role in probability and statistics, if we repeat an experiment independently a large number of times and average the result, what we obtain should be close to the expected value. This approach works in conjunction with concentration of human populations, a basic need for the evolution of human civilization. In *Cosmic City* Xenakis suggested that in high rise megatowers, the distance is shortened between the inhabitants (2.500-3000 inhabitants/hectare), thus connectivity and interaction within the community is encouraged.

- Heliocentric

In our current project called Heliocentric we explore sonification through live data retrieval which derive from planetary movements in our solar system. We ‘re going to talk a little about our process and the problems that came with it. So, we are going to divide the process in three parts: Data, Mechanism – Software and the actual synthesis.

## *Data*

### ***Retrieval***

First and foremost, we must decide on what kind of data interest us. Are we talking about tidal cycles, mass, or movement? If yes, do these values present an interest for our case and point? What aspect of sound are they capable of representing? Studying and understanding your source can really help with the conceptualization, the vision, and intention.

How about gathering the data? In this digital day and age, massive amounts of data are readily available online for about any topic imaginable. You can download GB of information spanning decades about any celestial body. This vastness of availability can prove useful when a clear intention has been established. Otherwise, it can become overwhelming. These collections although readily available are static in nature.

So, what about live data? As it turns out, it’s a bit more complicated. Real time calculation is a difficult and costly procedure and although there are organizations that perform them and provide the data, they do so mostly for presentation. We, as humans, can watch it happen in a website, but this representation isn’t suitable for computer manipulation. So, we scraped them! That is, programmatically collected and exported data in a format more suitable for our purpose. We used Python for that.

### ***Modeling***

We divided the data in two categories. Static and dynamic.

Static data refer to the physical characteristics of the cosmic bodies (including mass, gravity, inclination etc.). We are talking about values which are not prone to change over time (at least not in the miniscule amount of time occupied by the human experience of a musical piece). Based on those values, we determine sound traits and placement in the composition. For example, the separation between low and high pitched sounds is based on the mass of the celestial body.

Dynamic data are produced by measurements happening in real time. Those can be comprised of the current position of a celestial body (called ephemerides), orbital parameters etc. Those values affect aspects of sound that we defined as ever changing. For example, amount of delay or reverb, placement in the stereo spectrum (i.e., panning), pitch etc.

***Normalization***

The nature of raw data that come from planetary objects is not directly suitable for utilization in sonification. This is the reason that the data is normalized. Normalization can take many forms (it can be arbitrary or accountable). In our case we loosened up the limitations in order to have a working proof of concept (the initial sonic result was inaudible).

## *SuperCollider*

The actual purpose of our gathered data is to «feed» a series of synthesizers defined through SuperCollider. The goal is to produce a number of SynthDefs, each one of them representing a different planet of our Heliocentric system. General sound characteristics are based on the gathered static data while auditory attributes, like pitch, are constantly redefined via the dynamic ones.

## *Open Sound Control*

To achieve this real time «feeding», we needed a type of message exchange between the script retrieving the data (written in Python) and the actual synthesizers (developed in SuperCollider). Open Sound Control is a fantastic protocol for that job. There are implementations for a plethora of frameworks and languages making it super flexible while supporting many quality of life features. From multiple recipients of a single message to «bundles» of messages that must be received simultaneously.

## *Sound Synthesis*

Sound synthesis – succession or superposition of sounds – is defined via statistical models. Namely, stochastic processes. One of them is the Markov Chain.

Think of a Markov chain a bit like a drunken step. The place it will land depends only on where it currently is. So, the next event does not depend on any former events, only the one happening right now. In musical composition, this can lead to an unexpected turn of events.

Perform enough transitions (we are talking many, many transitions) and – based on the Law of Large Numbers – you will start to observe a kind of uniformity in the outcome.

The embodiment of sound through objective and material properties juxtaposed with a stochastic approach to synthesis create a sort of equilibrium between the quantifiable and the intangible. Between prediction and gambling.