

Retracing the Story of Bourges's Institute of Electroacoustic Music through Exploratory Programming and Live Visualizations

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Abstract

Bourges's Institute of Electroacoustic Music (IMEB) has been created in France in 1970 by the composers Françoise Barrière and Christian Clozier who directed it until its closure in 2011. During its forty years of existence this institute has been heavily involved in the development of electroacoustic music both on national and international scales. Its activities have included among others musical research, development of music-making software, creation of instruments and organization of music festivals and competitions. From 2005 to 2011, this Institute has donated all of its archives to the National Library of France that is to say a complete set of multimedia data about the history of electroacoustic music and its worldwide diffusion. In this paper will be describing the work that has been done to retrace the story of the international competitions organized by the IMEB using interactive data visualizations and multi-agent systems (MAS) that have been modeled based on the study of living organisms' behavior. The use of MAS will be presented as a way of exploring wide set of cultural data and retrieve new information stored in a database from the study of click streams.

Keywords

IMEB, Electroacoustic Music, Digital Humanities, Data Visualization, Exploratory Programming, Multi-Agent Systems, Machine Learning, Live Visualization.

Introduction

Bourges's Institute of Electroacoustic Music (IMEB) has been created in France in 1970 under the name "Groupe de musique électroacoustique de Bourges" (GMEB) by the composers Françoise Barrière and Christian Clozier who directed it until its closure in 2011. In 1994, the Bourges's Group of Electroacoustic Music became an Institute recognized as a National Center of Musical Creation by the French Ministry of Culture. During its forty years of existence this institute has been heavily involved in the development of electroacoustic music both on national and international scales. Its activities have included among others musical

research, development of music-making software, creation of instruments and organization of music festivals and competitions.

Artists all over the world have participated in the activities offered by the IMEB. According to Christian Clozier, 274 artists from 43 countries have worked in their studios on 765 different audio compositions and 4836 composers from 82 countries have presented their work during the competitions and music festivals they have organized over a period of more than thirty years.¹

From 2005 to 2011, the IMEB has donated all of its archives to the *Bibliothèque nationale de France* (BnF) that is to say a complete set of multimedia data about the history of electroacoustic music and its worldwide diffusion.

In this paper will be describing part of the work that has been done to explore these archives as part of a research project directed by Geneviève Mathon and that has been financially supported by the Arts-H2H Labex. We will only report the work that has been done to retrace the story of the international electroacoustic music competitions organized by the IMEB from 1973 to 2009 using interactive data visualizations and multi-agent systems (MAS) that that have been modeled based on the study of living organisms' behavior. The use of MAS will be presented as a way of exploring wide set of cultural data and retrieve new information stored in a database from the study of click streams.

Exploratory Programming

The IMEB's archives located at the BnF are composed of very different types of documents, both digital and analog. To retrace the story of the international competitions organized by the IMEB has been used mainly the minutes of each competition, and the digital

¹ Between 1973 and 2009, 14206 audio works have entered the competitions and 6637 have been interpreted during the festivals.

part of the IMEB's archives including a vast amount of information about their participants and the works they have submitted over the years to enter the competitions. The minutes of each competition organized from 1973 to 2009 reveal the name and the address of each participant, allowing us to count them but also to determine the number of submissions by composers and their provenance. The minutes also give information about each musical creation that has obtained a prize, letting us know their existence but also collect data about the evolving set of categories used to organize them each year.²

In addition to the minutes of the Bourges's international competitions, the content of 6292 digital folders has been explored. These folders have been created by Françoise Barrière and Christian Clozier. Together, they provide a rich panorama of the actors of the contemporary musical creation of the second half of the 20th century. Each folder regroups information about an electroacoustic composition that has been at least submitted to one competition or has been publicly presented during the music festivals "Synthèse" organized by the IMEB. It contains one uncompressed audio file that corresponds to a record of an electroacoustic composition, but also information about their author. Each folder includes a picture of a composer that has been associated with a bibliographic record. It contains fragments of a missing database too that report key information about the audio composition itself like its duration or its number of tracks. Several folders also include layouts for multichannel compositions like the one referencing the fifth element of the acousmatic work *Tao* composed by Annette Vande Gorne between 1989 and 1991 and named "Earth".

Context

The multimedia data contained in these folders represent a significant amount of information that doesn't share a common space of visibility. The information can't be perceived as a whole. The system that has been used to store the data doesn't offer an overview of the content of the folders nor provide an easy way to access the information related to a specific composer. The structure of the digital archive doesn't authorize to access all the folders containing an audio composition

² The evolution of the categories proposed by the IMEB to enter the competitions has been depicted using a Sankey diagram accessible at this address: <https://goo.gl/gaVND3>.

created by a specific artist or presented during the same edition of the international competitions. In order to retrieve the record of a specific audio composition we need to consult a table made by Christian Clozier that details the content of each folder.

Our work represents an attempt to facilitate access to the collected information by designing multiple interfaces that provide an overview of the content of the digital folders previously introduced but also let us browse and combine different types of data. Our intention is to present a combination of interfaces that can be used together to retrieve requested information but also permit their users to explore a digital archive without having beforehand a clear understanding of its richness and its structure.

The interfaces that are described below intend to become available in the BnF reading rooms in order to give access to the part of the IMEB archives they relate to. Their conception falls within the field of digital humanities. They respond to the need to create interfaces whose appearance and functionalities are intimately tied up to the nature of the data they let retrieve. We need interfaces that provide insights about the archives they give access to, and allow their users to reflect on their navigation paths.

The interfaces that are presented in this paper don't aim to replace any of the interfaces that the BnF already proposes to access information about electroacoustic music. They relate to the BnF general catalog by using the International Standard Name Identifier (ISNI) to uniquely identify each electroacoustic music composer that appears in the IMEB archives. Our project aims to link the data present in the digital folders that are part of the IMEB archives to the information about electroacoustic music already accessible to the public using application programming interfaces (API) provided by the BnF. Our intention is to give a better visibility to the selection made by Françoise Barrière and Christian Clozier while providing hyperlinks that let users access complementary sets of data.

The organization of a first hackathon in November 2016 inside the premises of the National Library of France reflects the willingness from this institution to open their databases to new practices by allowing third party to propose new ways to use and represent their data. The interfaces presented below reflect the same desire for openness.

They distinguish themselves from generic interfaces

by trying to provide an appearance and a set of features that has been specially designed to take into account the main characteristics and the specificities of a particular digital archive. These interfaces aim to be viewed as “generous interfaces”, an expression coined by Mitchell Whitelaw to describe rich and browsable interfaces that are able to “reveal the scale and complexity of digital heritage collections” (2015).

Process

To give more easily access to the content of the 6292 digital folders an interactive index has been designed. This index has been created upon a database that will regroup in the long term all the information contained in these folders but also other information found in the minutes previously mentioned in order to give an overview of all the composers that have participated in the competitions along the years.

The database that has been created doesn't only regroup data about composers mentioned in the digital folders. This database has been created to store information about all the composers that have participated in the competitions organized by the IMEB in order to be able to create data visualizations that allow their users to evaluate the representativeness of the content of these digital folders. The mention of all the composers that have been part of the history of the IMEB allows us to represent not only the information that is already accessible but also the information that is still missing and could be added gradually. It changes the way of seeing a database by presenting it as “forever incomplete” despite the large amount of data that has been gathered and its diversity.

In order to create the database, a multi-agent system (MAS) has been designed. First, the role of this MAS was to analyze the name, the first name and the address of each composer listed in the minutes in order to detect spelling errors but also to identify as a unique person each composer listed several times in the same minutes (or in different ones) using machine learning techniques.

The same MAS has also been used to determine the country of each composer and to enrich the database accordingly with this information. To sum up, this dynamic system has enabled us to gradually add information to the database, minutes by minutes, while identifying spelling errors and the participation of new composers each year by comparing them to each other. Then, the collected information about all the composers

listed in the minutes have been compared with the one already archived in the 6292 digital folders in order to give, with data visualizations, more visibility to the composers whose works have been conscientiously selected and archived by Christian Clozier. At the end of this process, 1202 different composers (that have participated in one competition or more) have been identified as having at least one electroacoustic composition archived in the digital folders.

Interactive Index

An interactive index has been created (see Figure 1) using all the information that has been collected and stored in a database. This index is able to give access to all the compositions that have been submitted to the international competitions and are part of the selection made by Christian Clozier and Françoise Barrière in order to be archived by the BnF.³ As a collection, they symbolize the quality and diversity of the electroacoustic compositions submitted to the Bourges's international competitions. The interactive index gives access to all of these compositions by referencing each of their authors with a gray square followed by at least one colored square.

The number of colored squares indicates the number of competitions each composer has entered while their color specifies the year of each of their participation. The red ones represent the first edition of the competitions organized in 1973 while the purple ones point out the last edition that took place in 2009. The colors go from red to purple passing by orange, yellow, green and blue. They allow to quickly identify composers that have participated in more than one competition but also the ones that have contributed repeatedly to the activities of the IMEB over a period of more than 30 years. The “long tail” distribution of electroacoustic compositions became immediately apparent. Most composers have only a small amount of their audio compositions archived, while the work of few of them is very well represented. For example, the digital folders about the work of the Swedish composer Åke Parmerud contain records about twenty different pieces.

Françoise Barrière and Christian Clozier had

³An online version of the interactive index is accessible at this address: <https://goo.gl/mlK68z>. To respect copyright laws, this version doesn't give access to any audio records available at the National Library of France.

already created lists of the winners of the Bourges's competitions. They have published statistics about the quantity of works that have been submitted each year, the number of composers that have been involved or the number of countries that have been represented. Some of them have been published in the numbers 6 and 7 of the magazine "Faire" released in 1985.

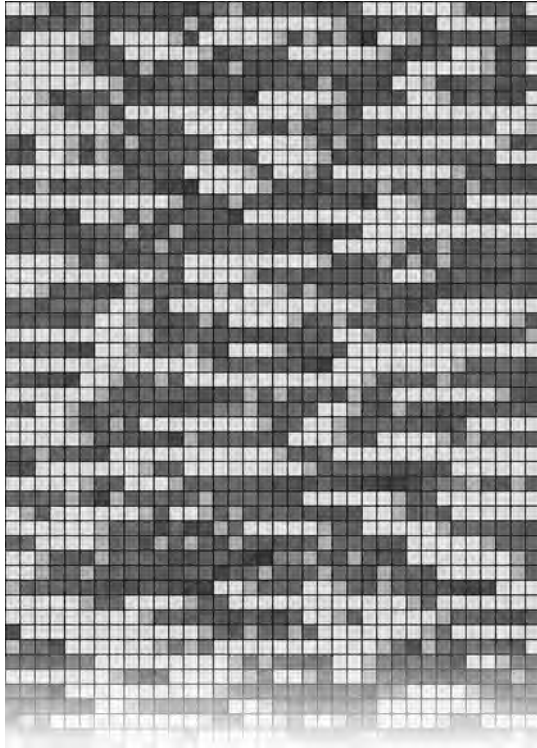


Figure 1. Part of the interactive index generated to give access to the IMEB archives

Compared to the information already communicated by the IMEB, the interactive index has the advantage to directly link a global representation of the competitions to all the elements that have made its construction possible. It gives access to all the data associated with the composers registered in the database, including information about their electroacoustic pieces that have been archived at the BnF. The design of this interface follows the "seeking mantra" defined by Ben Shneiderman to explore digital collections: "overview first, zoom and filter, then details-on-demand" (1996). First, the interface gives access to an overview of

the collection. Then, it lets its users choose between different parameters to filter the displayed elements as the one allowing them to hide all the rectangles referencing the work of composers who have less than x audio compositions archived. The parameters enable focus on a subset. Finally, a detailed information on a specific composer can be displayed. For example, selecting the rectangles that referenced the work of Maggi Payne lets us access the information concerning twenty-four electroacoustic pieces that have been archived including audio files. The works of Colombian composers like Germán Toro Pérez and Carlos Mauricio Bejarano Calvo are also indexed. A total of twenty-one electroacoustic compositions made by Columbian composers are accessible via the interactive index and associated with metadata about the compositions themselves (duration, date of creation, number of tracks, type) but also about their connection to the competitions (mainly category names and editions chosen by their authors to submit their works). If a user is looking for information related to a certain composer, he can also use a search bar to pinpoint the rectangles referencing its work. The interface emphasizes the exploration of the database but lets us also query it.

The interactive index has the ability to evolve in response to the edition of the database used to build it. The way the information is displayed shows that the database doesn't contain data about all composers. The role of the interactive index is to reveal not only what documents are accessible but also what information is missing and could still be added. It reveals the absence or scarcity of information about some composers. A void that can have as much meaning as the multitude of information available about other ones.

All the composers whose works are not present in the digital folders archived at the BnF (but are listed in the minutes) are part of the interactive index. The rectangles used to list their submissions are rendered with a semi-transparency in order to distinguish them from the composers whose works have been made accessible (see Figure 1).

The desire to show what information is missing has guided the work we have done to widen access given to the IMEB archives. It has played a decisive role during the design of the interactive index. Showing what electroacoustic compositions are missing permits us to evaluate more easily the representativeness of the selection made by Christian Clozier and Françoise

Barrière to keep track of the quality, the diversity and the evolution of the electroacoustic compositions made by artists from all over the world for more than 30 years. The visibility given to missing data lets us also explore the database by choosing to consult in priority information about composers whose work is mentioned several times and has been particularly well protected. It also guides users that are unfamiliar with electroacoustic music by highlighting famous composers' works.

In the next section of this paper will be presented another data visualization used to widen access given to the IMEB archives. Like the interactive index, its design keeps track of the information that is still not available. It also shows information about the content that has been already consulted and may have been overlooked.

Live Visualizations

Despite the time we spend using them, digital interfaces don't change so much. Few of their parameters can be modified or personalized based on the use we have of them but not many interfaces are able to adapt to the content they are giving access at a particular time. They don't change over time based on the information that has been consulted. The properties and features of digital interfaces belonging to national museums and libraries mainly respond to a need for consistency and standardization in order to facilitate access to their main catalogs and collections.

However, the capacity for an interface to evolve based on the nature of the data that has been consulted by a user can be very useful. It's particularly true when an interface gives access to the content of a database that cannot be fully explored in a short period of time due to the vast amount of data that has been archived or its complexity. We use the concept of "live visualization" to define a certain type of interfaces elements that evolves with the content they give access to.

The interactive index previously presented has been associated with one of them. Live visualizations are constructed based on the information a user is accessing. They are built in real time by analyzing click streams. Each time a user interacts with one of the rectangles that are part of the interactive index, a new element called agent is added to a live visualization. The node of information that has just been accessed using the graphical interface defines the new element properties and its behavior.

The colored squares of the interactive index are

used to list all the electroacoustic compositions that have been archived for a specific composer while a live visualization uses the information that has been consulted about a specific composer to create an autonomous agent. The term autonomous agent refers to an entity that can act on its virtual environment by itself without further orders given by a user or another digital entity. An autonomous agent has no leader. It processes the information from its environment and calculates an action (Shiffman, 2012). To sum up, a live visualization corresponds to a running multi-agent system. Each time a user interacts with the interactive index, a new agent is created using the node of information that has just been retrieved from the database.

A Bio-Inspired Approach

The multi-agent system has been defined based on the study of the behavior of living organisms. It doesn't intend to recreate nature or the complexity of its living organisms. This system has been designed to create group dynamics by following rules that have been elaborated from the observation of living organisms like fireflies.

Fireflies are known to emit flashes at regular intervals when isolated. They are also known to be able to synchronize their light emissions when they are in a group, their pulses converging upon the same rhythm until they synchronize. This collective behavior is the result of actions taken locally by insects that share the same environment and choose to get in synchronization with other living organisms that surround them.

The designed MAS use the same technic to create an overview of the content of the database that has been retrieved. Each agent is created from an information node that has just been requested by a user. This information node represents its genetic string. It determines its appearance (color, shape) and behavior (movement speed, actions). It allows them to appear with distinct colors and act differently based on the nature of the information they carry on.

Like fireflies, each agent has the ability to interact with other agents that are spatially closed to him. These interactions serve to create group dynamics. They are being used to compare information nodes and reveal the properties they have in common from the result of these local comparisons.

Then, the list of properties that are shared by most of the agents can be used to reorganize the whole

system. They became part of the interface of the live visualization allowing its users to choose between them in order to create new grouping between agents.

The main characteristic of this MAS is to be able to evolve in order to show in real time the main attributes of the information a user is accessing. It adapts to a constantly changing context in order to be able to use new properties to reorganize and to browse the data that have already been accessed.

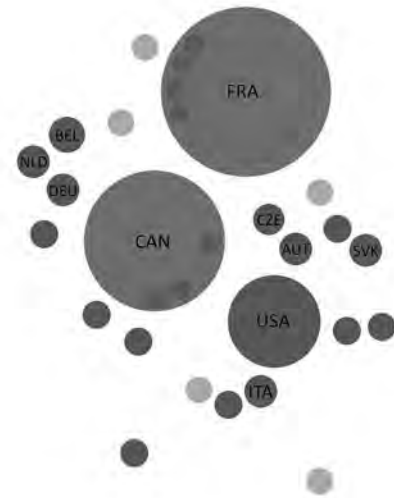


Figure 2. Example of live visualization created by analyzing click streams using a multi-agent system

The first version of the MAS that has been created gradually regroups by countries all the nodes that referenced a music composer.⁴ First, the agents that are part of the system interact between them to determine the attribute they have in common. Then, they choose to regroup with the ones having for this attribute the same value as them. They give birth to a new agent that represents this attribute and value: a country like France or Canada, for example. This agent represents a common point between at least two other primary agents that become its child nodes, nodes extending the one that has been created. This transformation and not disappearance

⁴ An online version of the multi-agent system is available at this address: <https://goo.gl/CIGMiY>. To respect copyright laws, this version doesn't give access to any audio records available at the National Library of France.

of nodes that share a common value (associated with the same attribute) permits us to keep track of all the nodes that have been consulted while regrouping them. Any node that becomes a child can be reached (as the information it transports) by selecting its parent.

Figure 2 shows parent and child nodes both. The gray elements are information nodes sharing any attributes with other ones while the green nodes are grouping of several nodes that can be opened to discover their content. The yellow ellipses are parent nodes that have been opened in order to access their child nodes.

Live visualizations can generate multiple groupings between agents based on the common attribute chosen to display them. They allow a user to acquire knowledge about its click stream. Live visualizations use common attributes that share the data that has been consulted to map out a navigation path and propose new directions to continue the exploration of the IMEB archives. MAS are a powerful tool for exploring databases. They let us build interactive interfaces that are able to evolve rapidly with a minimum of user input and knowledge about the content and structure of a database.

SMA allow us to do groupings that are not predefined. Groupings are the result of interactions between autonomous agents. This property allows the system to evolve based on the retrieval of new information nodes. They let us group the information that has been accessed by types. In this case, each agent can represent either a composer, a country or an audio composition and can be grouped accordingly. But the type of each information node is only one of many variables that can be used as a common denominator to gather multiple agents. The data type represents a property (as the provenance of a composer or an electroacoustic piece) and any property can be used to connect (or separate) two agents.

The role of the MAS is to detect by interaction the main properties that are shared by its agents in order to give to a user the power to choose one of them to map out its navigation path based on the property he is interested in. In the case of the IMEB archives, the MAS allow for example not only to group the composers by country but also to order the consulted audio compositions by categories (abstract music, program music, electroacoustic music with instruments, sonic art work, etc.). This possibility appears automatically once the information about several electroacoustic compositions belonging to the same category has been accessed.

While live visualizations have been primarily designed to regroup information nodes that have already been consulted, they permit their users to discover new elements of information too. Each primary node can be individually selected in order to access all the data associated with a specific composer or an electroacoustic piece.

Conclusion

Associated with interactive indexes, live visualizations let us imagine new ways to browse the content of any multimedia collections while displaying information about paths that have already been taken to explore them. By giving access to an interactive image that is able to reconfigure itself based on the choice made by a user, live visualizations emphasize browsing and visual exploration.

The interactions between agents create overviews that provide insights about browsing history and act as a guidance tool while a user is navigating through the records of a database. In the case of the IMEB archives, the live visualizations offer fragmentary views that reveal the richness and diversity of the electroacoustic compositions that are part of the digital archive.

Like any visualization tools, these live visualizations have their own limitations and do not claim to be able to replace other interface elements like search boxes to query databases or ordered lists to show data. They represent with the interactive index introduced in this paper, additional interface elements that work together. These navigation instruments have been designed to explore a specific archive, but we hope to be able to use the same technic to explore in the future other digital collections.

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