

8th International Conference
on New Interfaces for Musical Expression

NIME08

Casa Paganini – InfoMus Lab
Genova, Italy
June 4 – 8, 2008

Proceedings

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Editors

<http://nime08.casapaganini.org>
<http://www.casapaganini.org>
<http://www.infomus.org>

Printed by: BETAGRAFICA srl
ISBN:13-978-88-901344-6-3

In collaboration with

Facoltà di Lettere e Filosofia, Università degli Studi di Genova

Conservatorio di Musica “Niccolò Paganini”

Museo d’Arte Contemporanea Villa Croce

Ufficio Paganini, Comune di Genova

Polo del Mediterraneo per l’Arte, la Musica e lo Spettacolo

Accademia Ligustica di Belle Arti

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GOG – Giovine Orchestra Genovese

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Preface

We are proud to present the 8th edition of the International Conference on New Interfaces for Musical Expression (NIME08), hosted by Casa Paganini - InfoMus Lab, Università degli Studi di Genova.

Since 2005, InfoMus Lab has its new premises in the recently restored monumental building of S. Maria delle Grazie La Nuova - Casa Paganini. The International Centre of Excellence Casa Paganini – InfoMus Lab aims at cross-fertilizing scientific and technological research with humanistic and artistic research. Our research explores the relationships between music, science and emerging technologies: a mission that recalls Niccolò Paganini's spirit of experimentation.

New perspectives in contemporary music, in multimedia and digital luthery are among the main purposes of the Centre. Casa Paganini - InfoMus Lab studies new directions in scientific and technological research to improve quality of life (e.g., therapy and rehabilitation, leisure, sport, edutainment), to develop novel industrial applications and services (e.g., innovative interfaces and multimedia applications), to contribute to culture (e.g., museography, support cultural heritage through new technologies).

In this framework, the NIME Conference is a unique occasion for Casa Paganini to present on the one hand its research outcomes and activities to the scientific community and on the other hand to get inspiration and feedback for future work. Further, our efforts have been directed in involving in NIME the most important institutions and the whole city of Genova. For example, besides the monumental site of Casa Paganini, which hosts the welcome concert and the scientific sessions, concerts will be held at the Music Conservatory "Niccolò Paganini", demos at Casa della Musica, installations at the Museum of Contemporary Art "Villa Croce" and at the Faculty of Arts and Philosophy of the University of Genova, posters in the ancient convent of Santa Maria di Castello, club NIME performances at four different cafés and clubs in Genova (010, Banano Tsunami, Cafè Garibaldi, Mentelocale).

The scientific program of NIME08 includes 2 keynote lectures, 34 oral presentations, and 40 poster presentations, selected by the program committee out of 105 submissions. We are honored to welcome as guest speakers Xavier Serra, head of the music technology group at the University Pompeu Fabra in Barcelona, and Andrew Gerzso, director of the pedagogical department at IRCAM. Moreover, 2 panel discussions will address relevant issues in current research in sound and music computing: networked music performances and active listening and embodied music cognition. The program also includes 22 demos, organized in 3 demo sessions.

The artistic program encompasses a welcome concert, 3 NIME concerts, 4 Club NIME performances, and 7 installations. The NIME concerts and the Club NIME performances include 23 music pieces, selected by the program committee out of 63 submissions. The welcome concert on June 4 evening, offered by Casa Paganini – InfoMus Lab in collaboration with major music institutions in Genova, will present 4 novel music pieces by young composers using EyesWeb XMI: one of the pieces has been commissioned to tackle some open problems on networked performance faced in the EU Culture 2007 Project CoMeDiA; another piece has been commissioned to exploit a paradigm of "active music listening" which is part of the EU FP7 ICT Project SAME.

Four workshops will precede and follow the official NIME program on June 4 and 8: a workshop on technology enhanced music education, a tablet workshop for performers and teachers, one on Jamoma, and one on techniques for gesture measurement in musical performance.

Moreover, this year the 4th Sound and Music Computing (SMC) Summer School is held at Casa Paganini in connection with NIME08, on June 9 - 11, 2008. The program of the school includes plenary lectures, poster sessions, and hands-on activities. The school will address the following topics: Gesture and Music - Embodied Music Cognition, Mobile Music Systems, and Active Music Listening.

Organizing the NIME Conference is a huge effort, which is affordable only with the help of many people. We would like to thank the members of the NIME Steering Committee for the precious and wise suggestions, the demo and installation chair Corrado Canepa, the performance chair Roberto Doati, the club performance chair Donald Glowinski, and the members of our program committees who helped in the final selection of papers, posters, demos, installations, and performances.

We wish to thank the Rector of the University of Genova Professor Gaetano Bignardi, the Culture Councilor of Regione Liguria Fabio Morchio, and the Culture Councilor of Provincia di Genova Giorgio Devoto, whose support has been of vital importance for the creation and maturation of the project of Casa Paganini project.

We wish to thank Professor Gianni Vernazza, Head of the Faculty of Engineering, Professor Riccardo Minciardi, Director of the DIST-University of Genova, the colleagues Lauro Magnani and Franco Sborgi, Professors at the University of Genova; Patrizia Conti - Director of the Music Conservatory "Niccolò Paganini"; Sandra Solimano - Director of the Museum of Contemporary Art "Villa Croce"; Teresa Sardanelli - Head of the Direzione Cultura e Promozione della Città of Comune di Genova and Anna Rita Certo - Head of the Ufficio Paganini of Comune di Genova; Pietro Borgonovo - Artistic Director of GOG - Giovine Orchestra Genovese; Enrico Bonanni and Maria Franca Floris of the Dipartimento Ricerca, Innovazione, Istruzione, Formazione, Politiche Giovanili, Cultura e Turismo of Regione Liguria; Roberta Canu - Director of Goethe-Institut Genua; Vittorio Bo and Manuela Arata - Directors of Festival della Scienza; Francesca Sivori - Vice-President of the Centro Italiano Studi Skrjabiniani; Andrea Masotti and Edoardo Lattes - Casa della Musica; Giorgio De Martino - Artistic Director of Fondazione Spinola; Laura Santini of Mentelocale.

Finally, we thank the whole staff of InfoMus Lab - Casa Paganini for their precious help and the hard work in the organization of the conference.

Enjoy NIME 08!

Antonio Camurri and Gualtiero Volpe
NIME 08 Conference Chairs

Stefania Serafin
NIME 08 Program Chair

Genova, May 8, 2008

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NEW DATA STRUCTURE FOR OLD MUSICAL OPEN WORKS

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ABSTRACT

Musical open works can be often thought like sequences of musical structures, which can be arranged by anyone who had access to them and who wished to realize the work. This paper proposes an innovative agent-based system to model the information and organize it in structured knowledge; to create effective, graph-centric browsing perspectives and views for the user; to use authoring tools for the performance of open work of electro-acoustic music.

Keywords

Musical Open Work, Multimedia Information Systems, Software Agents, zz-structures.

1. INTRODUCTION

A classical musical composition (a Beethoven's symphony, a Mozart's sonata, or Stravinsky's *Rite of Spring*) posits an assemblage of sound units that the composer arranged in a closed, well-defined manner before presenting it to the listener. He converted his idea into conventional symbols, obliging (more or less) the (eventual) performer to reproduce the format devised by the composer himself. On the contrary, a number of music pieces (or, more general, of multimedia works) are linked by a common feature: the considerable autonomy left to the individual performer¹ in the way he chooses to play the work. Thus he is not merely free to interpret the composer's instructions following his own discretion (as happens in traditional music), but he must impose his judgment on the form of the piece, as when he decides in what order to group the sounds: a real act of improvised creation. In *Klavierstück XI*, Karlheinz Stockhausen presents to the performer a single large sheet of music

¹ As it is well known, the practical intervention of a performer (the musician who plays a music piece) is different from that of an interpreter in the sense of consumer (somebody who listens to a musical composition performed by somebody else). In this context, however, both cases are seen as different manifestations of the same interpretative attitude [5].

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NIME08, June 4-8, 2008, Genova, Italy
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paper with a series of note groupings; he then has to choose among these groupings, first for the starting unit and, next, for the successive ones in the order in which he elects to weld them together: in this way, he can *mount* the sequence of musical units in the order he chooses, changing the *combinative* structure of the piece. In Pierre Boulez' *Third Sonata for piano*, the first section (*Antiphonie, Formant 1*) is made up of ten different pieces on ten corresponding sheets of music paper. These can be arranged in different sequences like a stack of filing cards, though not all possible permutations are permissible. A particularly representative example of musical open work is *Scambi*, an analogue tape work created in 1957 by the Belgian composer Henri Pousseur at the Studio di Fonologia in Milan. By means of a specific process, called dynamic filtering (realized by using a special equipment, designed by Alfredo Lietti, the engineer of the studio), the composer is able to extract from noise animated time structures, then to process them further in different parameters, and thus to produce 32 sequences. These sequences can be arranged by anyone who had access to them and who wished to realize the work, according to certain rules regarding their order and possible overlapping.

Today several multimedia artistic works are 'in progress', 'open' in structure or in realization. Here the audio recording is included in a complex procedure of audio signal processing and where different writing systems (video, text, static pictures, gestures) flow together. In this field emerges the necessity to define suitable data structures and to convey, in a single (digital) medium, verbal and musical documents, pictures, audio and video signals.

The aim of this paper is to provide an innovative system for the performance of electro-acoustic music open works, considered as a representative subset of multimedia artistic works. Will be introduced innovative authoring tools able to make open a musical work, enabling the user to become self-author of new versions for a given work.

These topics are faced using an agent-based extension of the ZigZag model. Conceiving a system as aggregation of autonomous and cooperative agents is one of the most exciting aspects of the challenging arena known as multi-agent system (MAS); this perspective revolutionizes radically the way in which a model may be conceived and work [3]. In addition, the presence of ZigZag model guarantees a graph-centric browsing tool, which supports the representation of persistent context: user visualizes the unit of interest in relation to other associated units. But more than this, he sees the unit of interest from that unit's position relative to multiple perspectives or orientations. As case study, we chose the cited, complex electro-

acoustic open work (*Scambi* by Henri Pousseur), characterized by a variety of sequences and of different performance degrees of freedom.

2. ACTOR-BASED ZIGZAG MODEL

In order to present our model in section 3, this section introduces in two separate subsections (2.1 and 2.2) the basics of the ZigZag model and a brief description of the actors, a particular class of computational agents.

2.1 The ZigZag model

ZigZag [6] introduces a new, graph-centric system of conventions for data and computing; it separates the structure of information from its visualization (i.e. the way the data – text, audio, video - is presented to the user); therefore a ZigZag structure handles all the different visualizations necessary to realize an Electronic Edition of musical works.

The main element present in the ZigZag model is the *zz*-structure: it can be viewed as a multigraph where edges are colored, with the restriction that every vertex, called *zz*-cell, has at most two incident edges of the same color; the sub-graphs, each of which contains edges of a unique color, are called *dimensions*. The cells in a same dimension are linked into linear and directed sequences, called *ranks*. Each dimension can contain a number of parallel ranks, which are a series of distinct cells connected sequentially.

Since there is no canonical visualization, the pseudo-space generated by *zz*-structures is called *zz*-space and may be viewed in various ways. A view is a presentation of some portion of *zz*-space and is presented by a view program, which visualizes, for example, a region around a particular cursor.

A 2D view can be drawn picking a single cell as a focal point, and drawing the neighborhood around that cell along two chosen dimensions. By changing the chosen pair of dimensions, we can visually reveal, hide, and rearrange nodes in interesting ways. Considering that a *zz*-structure may be very large, and that there is usually not enough room in the 2D view for all of the cells, we restrict the dimension of the 2D view.

Some observations are necessary on the *zz*-cells; they are the principal unit of the system and they are conceived not only as passive containers of primitive data (i.e., text, graphics, audio, etc.) but they can have types, based either on their functions or on the types of data they contain. Thus, a *zz*-cell may have a variety of different properties and functions, such as executable program or scripts (this type of cell is called *progcell*), or represent the package of different cells (this type of cell is called *referential cell*).

Analogous observations can be made on the dimensions; in fact, they can be passive and nominal (merely receiving and presenting data) or operational, programmed to monitor changing *zz*-structures and events, and calculate and present results automatically (for example, the dimensions *d.cursor* and the dimension *d.clone*). From these considerations it turns out that it is reductive to associate *zz*-cells to passive entities meant simple nodes are in a graph. So, we have considered the opportunity to model a *zz*-cell by means of a specific class of computational agents, the actors.

2.2 Brief description of the actor model

The actor model [1] is a model of concurrent computations in distributed systems; it is organized as a universe of inherently autonomous computational agents, called

actors, which interact with each other by sending messages, improving on the sequential limitations of passive objects.

Each actor is defined by three parts: a **passive part**, which is a set of local variables, termed *acquaintances*, that constitute its internal state; an **active part**, that reacts to the external environments by executing its procedural skills, called *scripts*. This active part constitutes actor's behaviour; the third part is represented by the actor's **mail queue**, which buffers incoming communication (i.e. messages).

Each actor has a unique name (the uniqueness property) and a given behaviour; it communicates with other actors via asynchronous messages. Actors are reactive in nature, i.e., they execute only in response to messages received.

An actor can perform three basic actions on receiving a message: *create* a finite number of actors with universally fresh names, *send* a finite number of messages and *assume* a new behaviour.

The actor's behaviour is deterministic in that its response to a message is uniquely determined by the message contents and its internal state. Furthermore, all actions performed on receiving a message are concurrent.

In order to describe the actors in our model we adopt the formalism used in [3]:

```
(DefActor ActorName
 [inherits-from Class-Name]
 <acquaintances list>
 {scripts list})
```

Therefore an actor is described by specifying its superclass, its data part and its script part; the script part represents the set of scripts that can be executed.

3. THE MODEL

The architecture of our model is organized in two layers: a *component layer* contains the *zz*-cells, those are actors specifically designed to model the audio documents domain; a *meta layer* contains the actors classes specialized, for example, to manage connections among *zz*-cells or to generate specific views on them. The interaction between actors is defined using the diagrammatic language AUML (Agent Unified Modelling Language) [8], extension of UML for agents.

3.1 Component layer

The component layer is defined in relation to the magnetic tape structure: each open reel is usually composed by several physical segments, i.e. pieces of magnetic tape connected by means of adhesive tape (called junction).

In each segment, the audio signal is recorded in one, two or more tracks. Following this structure we define the actors *Source*, *PhysicalSegment*, and *DigitalSignal*. Moreover, the actor *LogicalSegment* is introduced, with the aim to compare the sources on the basis of a segmentation that is different by the physical one. The actor *Source* represents the overall characteristics of the document, such as the tape width (typical values are 1/4, 1/2, 1, and 2 inch) and the cataloguing fields.

```
(DefActor Source
 <physicalSegments width archive shelfMark inventory
 conservationCondition ...>
 {calculateDuration ...})
```

It contains also a list of *physicalSegments*, which compound the open reel tape. This actor is able to perform several

actions, e.g. the script `calculateDuration` asks each physical document for his length and rate and it calculates the total duration of the tape. The `LogicalSegment` carries out a virtual partition of the Source.

```
(DefActor LogicalSegment
  <start length source rate equalization
  noiseReductionSystem
  tracksLayout digitalSignal audioQuality ...>
  {getQuality getSignalProperties ...})
```

Its acquaintances are the start time and the duration of the segment, a pointer to the corresponding source, the recording rate (typical values are 7.5 or 15 inch/s), the equalization (e.g. IEC1/CCIR), the `noiseReductionSystem` (e.g. Dolby or dbx), the `tracksLayout` (i.e. the tracks number and width), a pointer to the `digitalSignal` representing the audio recorded on each track, and an `audioQuality` index, that can be subjectively specified by the user. If the `audioQuality` field is left blank, the script `getQuality` asks the `digitalSignal` to estimate the signal to noise ratio of each track and returns an index of quality. The script `getSignalProperties` asks the `digitalSignal` for the digital audio of each track and estimates if the audio signal is monophonic, stereophonic, or polyphonic. This information doesn't always correspond to the number of tracks, because, following the practice of magnetic recording, a monophonic signal can be recorded on a multi-track format, writing the same signal in all the tracks. A specialization of this actor class is the `PhysicalSegment` actor that specifies geometrical features of the segment, such as the angle of his junction.

```
(DefActor PhysicalSegment
  [inherits-from LogicalSegment]
  <junctionAngle ...>
  {getFadeDuration ...})
```

The script `getFadeDuration`, starting from the geometrical properties of the junction, calculates the duration of the fade-in and fade-out of the audio at the segment edges. The `NumericSignal` actor represents the audio signal recorded on the tracks.

```
(DefActor NumericSignal
  <size samplingRate resolution data[i,j]>
  {estimateSNR calculateSTFT
  calculateAmplitudeEnvelope})
```

Its acquaintances are related to the numeric format: number of samples, sampling rate, and resolution. `data[i,j]` is a matrix, with a row for each track and a column for each sample. This actor can perform several actions that, using signal-processing techniques, calculate signal to noise ratio, short-time Fourier transform, amplitude envelope or other kinds of representations.

3.2 Meta layer

In order to manage the information in a `zz`-structure context, a meta layer is added. Following the rank definition introduced in ZigZag model, the actor `Rank` can be described as an ordered list of actors, belonging to the same dimension. Each specific dimension contains one or more ranks. Examples of dimensions are:

- *source* dimension, that composes given sources as an ordered sequence of segments;
- *equivalent segments* dimension: links segments with a common music content present in different sources.

For each dimension, we define specialized classes of actors, (such as `SourceRank` and `EquivalentSegmentsRank`).

```
(DefActor SourceRank
  [inherits-from Rank]
  <source ...>
```

```
{swapSegment ...})
```

```
(DefActor EquivalentSegmentsRank
  [inherits-from Rank]
  <sources ...>
  {compareQuality ...})
```

Another typology of meta-actor is the `generativeProcess`; this class is devoted to generate dynamic new virtual hyperdocuments.

```
(DefActor generativeProcess
  <... >
  {generateView createSource})
```

4. CASE STUDY

We propose now the analysis of an interesting case study, in which we use a subset of scripts and actors defined above: the Pousseur's electronic work *Scambi*. Writing about his work in 1959, Pousseur ended by envisaging the day when technology would allow listeners to make their own realizations of the work (either following his 'connecting rules' or not) and to give the, now active, listener the experience of a temporal event open to his intervention and which could therefore be elevated in type, as vital, creative freedom [7]. The active listener becomes, in effect, a composer; reception and interpretation are expressed as (musical) production.

In our paper, Pousseur's invitation to interpret his work creatively as re-composition has been extended to remix and other types of appropriation that were not only permitted but welcomed by the composer [7] (a position that associates him with popular-music culture in which such freedom is assumed).

In our case study, we have collected the original 32 audio sequences realized by Pousseur, thanks to the 'Scambi Project', Lansdown Centre for Electronic Arts, School of Arts, Middlesex University, UK (<http://www.scambi.mdx.ac.uk>).

Thanks to the cooperation of different classes of actors, our system allows user-author to surf among the existing performances of *Scambi* (by the composer, Luciano Berio and others) and to create a new virtual source, automatically picking up the audio sections following the 'connecting rules' proposed by the composer. Moreover, the user-author can establish himself stochastic rules.

Thanks to the separation of structure (dimensions) from content (`zz`-cell) in `zz`-structures, different users can customize their workplace and the visualization of same contents, creating new dimensions or new virtual performances. This is achieved activating specific actor collaboration schemes and is shown in following section 4.1.

4.1 New performances

The four acoustic parameters taken into account by Pousseur are:

- 1) statistical tempo (from slow to fast);
- 2) relative pitch (from low to high);
- 3) homogeneity of the sound pattern (from dry to strong reverb);
- 4) continuity (from long breaks to continuous sound).
In Figure 1 is detailed the start- and end-situations for each sequence.

We define *equivalent segment* as the sequences that can follow the current sequence on the basis of Pousseur's intention to ensure a transition without break (in the four

parameters) from one sequence to the next (a sort of ‘continuity principle’).

Family	Sequence	Pitch	Speed	Hom.	Cont.	Dur.
1	1-2	0/1	1/1	1/0	0/0	42"
2	3-4	0/1	1/1	0/1	1/1	42"
3	5-6	1/0	1/1	0/0	0/1	42"
4	7-8	1/0	1/1	1/1	1/0	42"
5	9-10	1/1	1/0	1/0	1/0	30"
6	11-12	1/1	1/0	0/1	0/1	30"
7	13-14	1/1	0/1	0/0	0/0	30"
8	15-16	1/1	0/1	1/1	1/1	30"
9	17-18	0/0	0/1	1/0	0/1	30"
10	19-20	0/0	0/1	0/1	1/0	30"
11	21-22	0/0	1/0	0/0	1/1	30"
12	23-24	0/0	1/0	1/1	0/0	30"
13	25-26	1/0	0/0	1/0	1/1	42"
14	27-28	1/0	0/0	0/1	0/0	42"
15	29-30	0/1	0/0	0/0	1/0	42"
16	31-32	0/1	0/0	1/1	0/1	42"

Figure 1. Characteristic per sequence (from: Decroupet [4]).

This segmentation process can be iteratively applied to all the sequences, obtaining a set of audio segments linked along two dimensions. The user-author can generate new performances mixing different sequences also in polyphonic structure. To do so, user can apply deterministic laws (given by the composer), stochastic models or self-oriented choices; this allows user to generate new ‘reading’ performances of an open work.

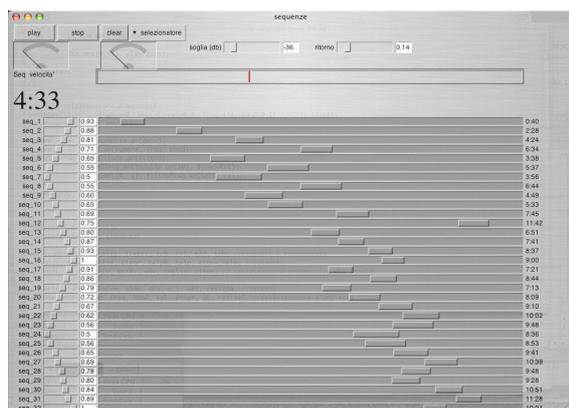


Figure 2. A screenshot of the system. X-axis: time, Y-axis: sequences. The user can be realize a polyphonic structure and modify the pitch, the duration and the volume of each sequence.

We assume that an user is interested in creating the new performance starting from a segment src_n ; this request is captured from the meta-actor generativeProcess and it is forwarded from it to the source rank r^{src} (that manages the logical segments src_1, \dots, src_{32}). r^{src} sends a synchronous multicast message (CalculateRule) to all its logical segments. In order to enable the comparison among its

features and that of others segments, each segment ($src_j, j=1, \dots, 32$) assigns this task to the rank r^{e-sj} (that manages the logical segments able to follow src_n on the basis of Pousseur’s ‘continuity principle’). Each r^{e-sj} contacts (in synchronous multicast way) all its components ($e-src_{js}, s = 1, \dots, m$) and, following stochastic law defined off-line by the user or by means of user input, it choices the components with the best matching. This information is returned to generativeProcess. This last actor collects the segments and creates the new requested performance. In Figure 2 a screenshot of the system is showed.

5. CONCLUSION

The era of high modernism, in which concept of the open work was a radical resistance to this dominant aesthetic, has been relegated to history. The contemporary western culture, as it is well-known, assumes that all musical works are *open* to perpetually renewed interpretation by listeners, musicologists, analysts, and performers [2]. In particular, in multimedia domain no work is permitted to resist endless (interactive) interpretation. This contemporary situation is partly the effect of the invention of the concept of the open musical work, in which Pousseur was a precursor. For this reason, the interest in *Scambi* is particularly high today, as also proved by the success obtained by the *Scambi Project* (www.scambi.mdx.ac.uk/). One effect of our work might be to free the historical musical open work from its iconic status as history, to revive and redefine its specific openness within general (digital and interactive) openness, and to return a continuous presence to it by opening it up to interpretive renewal.

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