

# Celebrating 10 Years of the MusMat Research Group: Survey of Activities and Future Perspectives

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## Abstract

*In the year of 2022 the MusMat Research Group completes 10 years of existence. During this time the group developed several paramount activities for stimulate, promote and propagate the teaching and investigation of music and mathematics, specially in Brazil. This document is a landmark in our history, presenting a comprehensive overview of our previous achievements and pointing out to future goals.*

## I. INTRODUCTION

The activities of the group MusMat (Fig. 1) were launched in 2012 by Carlos Almada, Daniel Moreira de Sousa, and Pauxy Gentil-Nunes, who realized that their individual research projects, developed in the Music Graduate Program at the Rio de Janeiro Federal University, although distinct from each other in essence, objectives, and methodology, orbited around a common denominator, namely, the intersection of music and mathematics.

Formally registered in 2013 as an academic research group, MusMat has, since then, enlarged its frontiers, by incorporating new ideas, lines of investigation, projects, as well as students, and, especially, members. In 2014 Liduino Pitombeira joined MusMat, which represented a



**Figure 1:** Three logos of MusMat research group over the years.

considerable expansion of the area of interests covered by the group. In 2020, due to personal reasons, Gentil-Nunes left MusMat. To replace him, the remaining members decided then to invite three mathematicians (who are also talented musicians), inaugurating a new phase for the group, a phase of extraordinary improvement and growth. They are Hugo Carvalho, Carlos Mathias, and Cecília Saraiva.

Besides acting at Undergraduate and Graduate levels (by giving disciplines, lectures, as well as supervising undergraduate, master, and doctorate students' projects and the research of post-doctoral fellows), the MusMat members have dedicated great part of their efforts to publish two annual editions of *MusMat • Brazilian Journal of Music and Mathematics* (since 2016), to organize an annual conference on Music and Mathematics (also since 2016), and, more recently, to produce a podcast intended to make specific researches and general information about the confluence of these two central subjects known to a wider public.

The next sections intend to concisely describe some of MusMat's main achievements along the last ten years.

## II. MUSMAT CONFERENCES

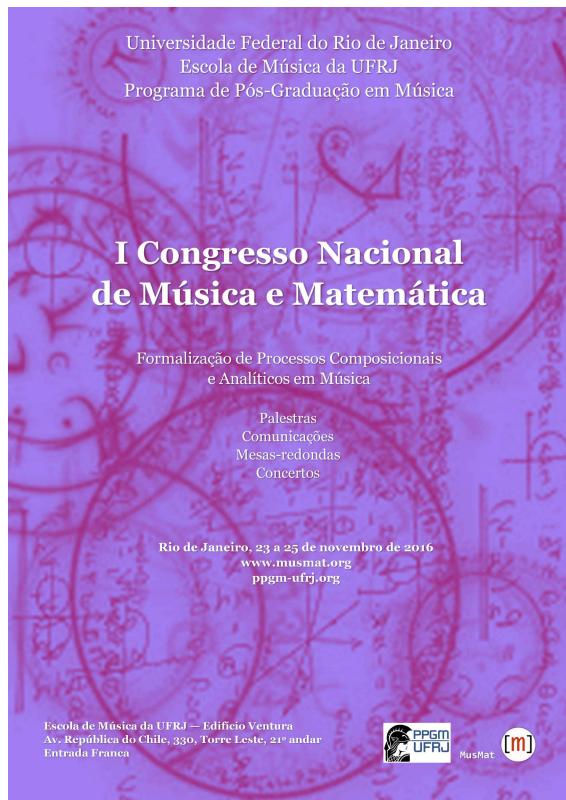
### i. 2016

The first MusMat conference took place in November of 2016, at the School of Music of the Federal University of Rio de Janeiro (Figs. 2 and 3). In this first edition (as well as in the next two ones) the conference was still held nationwide. Noteworthy names from Brazilian academic scenery were invited to present their research projects.

In addition to sessions of oral communications, the 2016 MusMat conference included a concert with compositions for flute, bassoon and piano based on the researches of the three MusMat members Liduino Pitombeira, Daniel Moreira, and Carlos Almada.<sup>1</sup> The following lectures and round tables were also presented:

- First day (Nov/23/2016):
  - Keynote by Rodolfo Coelho de Souza (University of São Paulo), entitled *Conceitos Matemáticos Utilizados na Composição de A Máquina de Pascal em Pernaguá* (*Mathematical Concepts Used in the Composition of A Máquina de Pascal em Pernaguá*);

<sup>1</sup>Although the concerts included pieces by others composers, for the sake of conciseness here are included only pieces by members of the MusMat Group. For the same reasons, sections of oral communications are not listed.



**Figure 2:** Poster of the 2016 MusMat Conference.



**Figure 3:** Participants of the 2016 MusMat Conference.

- Second day (Nov/24/2016):
  - Round table 1 – "Música e matemática: contextos" (Music and Mathematics: Contexts). Participants: Alexandre Reche (Federal University of Rio Grande do Norte) – *On the Relation of Quality and Quantity in the Context of Musical Composition*  
Carlos Mathias (Federal Fluminense University) – *Educação matemática de deficientes visuais: uma proposta por meio de sons, ritmos e atividades psicomotoras* (Mathematics Education for the Visually Impaired: A Proposal through Sounds, Rhythms and Psychomotor Activities)
- Third day (Nov/25/2016):
  - Round table 2 – "Música e matemática: conceitos" (Music and Mathematics: Concepts). Participants: Marcos Sampaio (Federal University of Bahia) – *Contour Algorithms Review*  
Carole Gubernikoff (Federal University of the State of Rio de Janeiro) – *Algumas considerações sobre as relações entre música e matemática* (Some Considerations on the Relations between Music and Mathematics)
  - Concert – Works for flute (Eduardo Monteiro), bassoon (Aloysio Fagerlande), and piano (Flávio Augusto)
    - \* *Patrônio quieto*, Op. 207 (Liduino Pitombeira)
    - \* *Germinata III* (Carlos Almada)
    - \* *Sagração de um fauno na primavera* (Daniel Moreira)

## ii. 2017

In the second MusMat conference, that took place in December of 2017 at the School of Music of the Federal University of Rio de Janeiro (Fig. 4), we invited outstanding researchers to cover different studies on the intersection between music and mathematics. Also, a concert performed by the Trio de Palhetas do Rio de Janeiro premiered pieces by Liduino Pitombeira and Carlos Almada that are deeply related to their respective research work.

- First day (Dec/5/2017):
  - Keynote by Gabriel Pareyon (Guadalajara University), entitled *Mathematical Analogy Versus Metaphor in Understanding of Music as a Biochemical and Biological Structure*;
- Second day (Dec/6/2016):
  - Lecture by Carlos Volotão (Military Engineering Institute of Rio de Janeiro) entitled *Composição musical inteligente* (*Intelligent Music Composition*).
  - Concert *Matemúsicas* (*Mathmusics*), performed by the Trio de Palhetas do Rio de Janeiro (Rodrigo Herculano, oboe; Igor Carvalho, clarinet; Carlos Bertão, bassoon)
    - \* *Vientos Tejanos*, Op. 203 (Liduino Pitombeira)
    - \* *Germinata I* (Carlos Almada)

## iii. 2018

In 2018 (Fig. 5) the conference was considerably expanded, not only in the number of activities and guests – both from Brazil and overseas –, but also in the musical works especially composed for the event, which were distributed into two concerts.

- First day (Dez/3/2018):
  - Keynote by Robert Peck (Louisiana State University), entitled *The State of the Art: New Directions in Music and Mathematics*

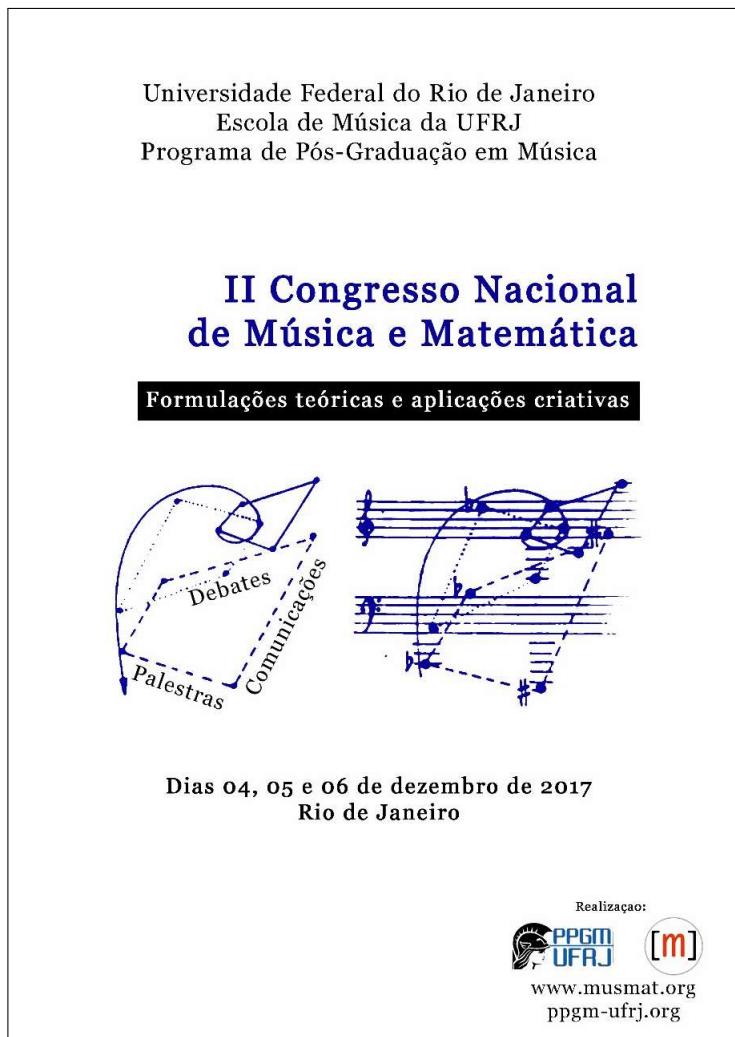


Figure 4: Poster of the 2017 MusMat Conference.

- Round table 1 – “Inovações conceituais em análise musical” (Conceptual Innovations in Music Analysis). Participants:  
Didier Guigue (Federal University of Paraíba) – *Análise da Orquestração, uma proposta de formalização (Orchestration Analysis, a Proposal for Formalization)*  
José Augusto Mannis (University of Campinas) – *Análise como processo cognitivo musical (Analysis as a Musical Cognitive Process)*  
Arthur Kampela (Federal University of the State of Rio de Janeiro) – *Modulação Micrométrica e Intuição Assimétrica: uma abordagem complementar (Micrometric Modulation and Asymmetric Intuition: A Complementary Approach)*
- Second day (Dez/4/2018):
  - Round table 2 – “Inteligência artificial em música” (Artificial Intelligence in Music). Participants:  
Carlos Volotão (Military Engineering Institute of Rio de Janeiro) – *O papel das redes*



Figure 5: Poster of the 2018 MusMat Conference.

*neurais na composição musical (The Role of Neural Networks in Music Composition)*  
José Gabriel Rodrigues (Federal University of Rio de Janeiro) – Deep Learning e redes convolucionais (Deep Learning and Convolutional Networks)

- Concert 1 – *Homenagem a Debussy (Hommage to Debussy)*, piano works performed by Tamara Ujakova, Thallyson Rodrigues, and Flavio Augusto.

- \* *Impressões 1, 2 e 3* (Daniel Moreira)
- \* *Liberjongo 2* (Pauxy Gentil-Nunes)
- \* *Trois monuments, Op. 234* (Liduino Pitombeira)
- \* *Pop Prelúdios* (Carlos Almada)

- Third day (Dez/5/2018):

- Lecture, by Richard Cohn (Yale University), entitled *Glass Graphics*
- Lecture, by Robert Morris (Eastman School of Music), entitled *4, 4, 4: A Talk on my String Quartet Quattro per Quattro*
- Round table 3 – "Diálogos inovadores entre música e matemática" (Innovative Dialogues between Music and Mathematics). Participants:  
Cecília Saraiva (Federal University of the State of Rio de Janeiro) – *Musicalizando a matemática: um olhar interdisciplinar e humanista* (*Musicalizing Mathematics: An Interdisciplinary and Humanistic Perspective*)

*plinary and Humanistic View)*

Carlos Mathias (Federal Fluminense University) – *Música e matemática, aritmética e ritmos* (*Music and Mathematics, Arithmetic and Rhythms*)

Ciro Visconti (University of São Paulo) – *Grafos neoriemannianos para além das tríades e tétrades* (*Neo-Riemannian Graphs beyond Triads and Tetrads*)

- Fourth day (Dez/6/2018):

- Lecture, by Stephen Guerra (University of Miami), entitled *An Introduction to Afro-Diasporic Hemiolic Metric Space*
  - Concert 2 – Abstrai Ensemble – Pedro Bittencourt (saxes), Pauxy Gentil-Nunes (flute and electronics), Fábio Adour (guitar)
    - \* *Suarabácti* (Pauxy Gentil-Nunes)
    - \* *Mímesis* (Daniel Moreira)
    - \* *Artigo primeiro* (Carlos Almada)
    - \* *Eco morfológico Op. 206* (Liduino Pitombeira)

iv. 2019

In that year the MusMat conference received international status, and English became the official language for the communications. Exceptionally, the event was also held in conjunction with the Third Conference of the Brazilian Association of Music Theory and Analysis (TeMa), at the Club of Engineering of Rio de Janeiro (Fig. 6). Distributed across the sessions, a record number of outstanding works concerning music and mathematics was presented along the whole week.

- First day (Oct/21/2019):

- Round table 1 – "Tonal Theories". Participants:  
José Oliveira Martins (University of Coimbra) – *Non-octave Tonal Frameworks: Mistuning, Pitch Fields, and Transpositional Tonnetze*  
Patrick McCreless (Yale University) – *Theories of Chromaticism: Pedagogical Implications*
  - Round table 2 – "Theories of Textures". Participants:  
Didier Guigue (Federal University of Paraíba) – *A Proposal to Analyze Orchestrations from the Texture*  
Pauxy Gentil-Nunes (Federal University of Rio de Janeiro) – *Reading of Textural Functions, Instrumental Techniques and Space through Particisional Complexes*
  - Lecture, by Robert Morris (Eastman School of Music), entitled *Issues in Compositional Theory*
  - Concert 1 – works performed by Marina Spoladore (piano) and the Saxophone Quartet of UFRJ (Pedro Bittencourt, Vinicius Macedo, Fernando dos Santos, and Paulo Félix).
    - \* *Canções da velha era* (Pauxy Gentil-Nunes)
    - \* *Ponto, linha e plano* (Daniel Moreira)
    - \* *Berimbau, Op. 216b* (Liduino Pitombeira)
    - \* *Park Suite* (Carlos Almada)

- Second day (Oct/22/2019):

- Round table 2 – "Post-Tonal Theories". Participants:  
Robert Morris (Eastman School of Music) – *Issues in Compositional Theory*  
Paulo de Tarso Salles (São Paulo University) – *Voice-leading among Pitch Class Sets: Revisiting Allen Forte's Genera*



Figure 6: Poster of the 2019 MusMat Conference.

- Lecture, by José Oliveira Martins (University of Coimbra), entitled *Scalar Dissonance and the Polytonal/Modal Impulse in Twentieth-Century Music*
- Concert 2 – works for flute (Eduardo Monteiro), bassoon (Aloysio Fagerlande), and piano (Flávio Augusto).
  - \* *Patrônio quieto*, Op. 207 (Liduino Pitombeira)
  - \* *Quatro choro-fugatos para piano* (Carlos Almada)
  - \* *Sagração de um fauno na primavera* (Daniel Moreira)
- Third day (Oct/23/2019):
  - Round table 3 – "Theories of Popular Music". Participants:  
Gabriel Pareyon (University of Guadalajara) – *Non-Linear Approach to Popular Musicalities through a Non-Western Mathematical Understanding of Rhythm, Intonation and Locally Generated Harmony*  
Júlio Herrlein (Federal University of Rio Grande do Sul) – *Popular Music and the Rhythmic Set-Class Theory: A Survey*
- Fourth day (Oct/24/2019):
  - Round table 4 – "Current Theories and Technologies". Participants:  
Jean Pierre Briot (Centre National de la Recherche Scientifique – CNRS) – *Progress and Challenges for Music Generation by Deep Learning*  
Charles de Paiva (University of Campinas) – *Reflections on Algorithmic Models of Symbolic Representation for Computer-Assisted Musical Analysis*  
Rodrigo Schramm (Federal University of Rio Grande do Sul) – *Computational Information Retrieval Techniques applied to Musical Analysis*
- Fifth day (Oct/25/2019):
  - Lecture, by Gabriel Pareyon (University of Guadalajara), entitled *Peircean Mathematics for Musicology: Transcending Heraclitus Melancholy through Harmonic Synechism*

## v. 2020

Due to COVID-19 pandemics, the 5<sup>th</sup> MusMat conference was held remotely (Fig. 7). For the first time, in addition to communications, lectures, and round tables, the conference included five concerts (with different instrumentations), whose video previously recorded were broadcasted through MusMat's channel in YouTube (as well as all the other live activities). In order to access them, please visit <https://www.youtube.com/c/musmat>.

- First day (Dec/8/2020):
  - Keynote, by Dmitri Tymoczko (Princeton University), entitled *Repeating Contrapuntal Patterns*
  - Round table 1 – "Algorithms and Music". Participants:  
Moreno Andreatta (University of Strasbourg) – *Processes and Techniques of 'Mathemusical' Learning: How to Teach Maths through Music via Computer Science*  
Marcos Sampaio (Federal University of Bahia) – *Computational Musicology, Algorithms, and Dataset*  
Jônatas Manzolli (University of Campinas) – *Dialogue between Composition and Analysis through Computer Models*
  - Concert 1 – works for solo clarinet (performed by José Batista Júnior)

- \* *Canopus*, Op. 253 (Liduino Pitombeira)
- \* *Uma bossa* (Carlos Almada)



**Figure 7:** Poster of the 2020 MusMat Conference.

- Second day (Dec/9/2020):
  - Round table 2 – "Probability and Music". Participants:  
David Temperley (Eastman School of Music) – *Probabilistic Models of Musical Pleasure*  
Fabian Moss (École Polytechnique Fédérale de Lausanne) – *The Importance of Modeling in Computational Musicology*  
Hugo Carvalho (Federal University of Rio de Janeiro) – *Statistical Models for Music Emotion Recognition*
  - Concert 2 – works for voice (Andréia Adour) and guitar (Fábio Adour)
    - \* *Os 4 Elementos* (Liduino Pitombeira, text by Petrucio Viana)
    - \* *Fiboema 1* (Carlos Almada, text by Petrucio Viana)
    - \* *Epílogo* (Daniel Moreira, text by Stefan Zweig, translated by Manuel Bandeira)
- Third day (Dec/10/2020):
  - Round table 3 – "Logic and Music". Participants:  
Robert Peck (Louisiana State University) – *Beat-Class Set Classes and the Power Group Enumeration Theorem*  
Petrucio Viana (Federal Fluminense University) – *On the Logicity of Music*  
Francisco Aragão (Federal University of Ceará) – *Logic and the Logics of Music*

- Lecture, by Scott Murphy (Kansas University), entitled *Common Musical Sets as Pareto-Optimal Peaks*
- Concert 3 – works for solo bassoon (performed by Ariane Petri)
  - \* *Rocknária* (Carlos Almada)
  - \* *Alvorada* (Daniel Moreira)
- Fourth day (Dec/11/2020):
  - Round table 4 – "Temporal Organizations in Music". Participants:  
Carlos Mathias (Federal Fluminense University) – *Rhythmic Illusions*  
Arthur Kampela (Federal University of State of Rio de Janeiro) – *Time Suspended and Metric Grace-Notes: A Cognitive Short-Circuit between the Metronomic, the Metonymic and the Mnemonic*  
Marcelo Coelho (Souza Lima) – Suite I Juca Pirama: *Adapting José Eduardo Gramani's Rhythm to Ron Miller's Modal Jazz*
  - Lecture, by Rodolfo Coelho de Souza (São Paulo University), entitled *The Role of Mapping Function in the Algorithmic Musical Composition*
  - Concert 4 – *Enlarge Your Sax*: Works for saxes and electronics (performed by Pedro Bittencourt)
- Fifth day (Dec/12/2020):
  - Round table 5 – "Music Signal Processing". Participants:  
Rodrigo Schramm (Federal University of Rio do Grande do Sul) – *Improving the Classification of Rare Chords*  
Martín Rocamora (Universidad de la República del Uruguay) – *Signal Processing for Music Analysis from Audio Recordings*  
Bruno Masiero (University of Campinas) – *Spatial Audio and Object-Oriented Coding*
  - Lecture, by François Pachet (Spotify) and Jean-Pierre Briot (CNRS/ Lip6/ PUC - Rio de Janeiro), entitled *Some Reflexions about AI-Assisted Music Composition*
  - Concert 5 – *Electroacoustics and Alike*, organized by Marcelo Carneiro, Lilian Campesato, Paulo Dantas, and Mariana Carvalho

vi. 2021

The MusMat 2021 conference (also held remotely) celebrated the compositional production and theoretical thoughts of Arnold Schoenberg, particularly considering his contributions for the formalization of the use of mathematics for music composition (Fig. 8). An extraordinary number of experts ("Schoenbergians", in the strict sense), from several countries, presented works centered in analytical aspects of Schoenberg's production – both as a composer and theoretician –, as well as in their own studies, related in some way to Schoenberg's legacy.

- First day (Oct/18/2021):
  - Keynote, by Walter Frisch (Columbia University), entitled *Schoenberg's Creative Journey, 1897-1912*
  - Round table 1 – "Compositional Processes on Schoenberg's Music". Participants:  
Carlos Almada (Federal University of Rio de Janeiro) – *The Principles of Grundgestalt and Developing Variation in a Bio-Mathematical Model*  
Flo Menezes (State University of São Paulo) – *Schoenberg, the Harmony and its Colors*

Achille Picchi (State University of São Paulo) – Nacht, *Number 8 from Pierrot Lunaire by Arnold Schoenberg: A Perspective from the Artsong Theory on the Text-Music Relationship and its Unfoldings*

- Concert 1 – works for piano / "Hommage to Schoenberg (I)" (performed by Patrícia Mol, Ronal Silveira, Tamara Ujakova, Miriam Grosman, and Cristiano Vogas)

- \* *Mente insana em Copacabana* (Carlos Almada)
- \* *Elucubrações* (Daniel Moreira)

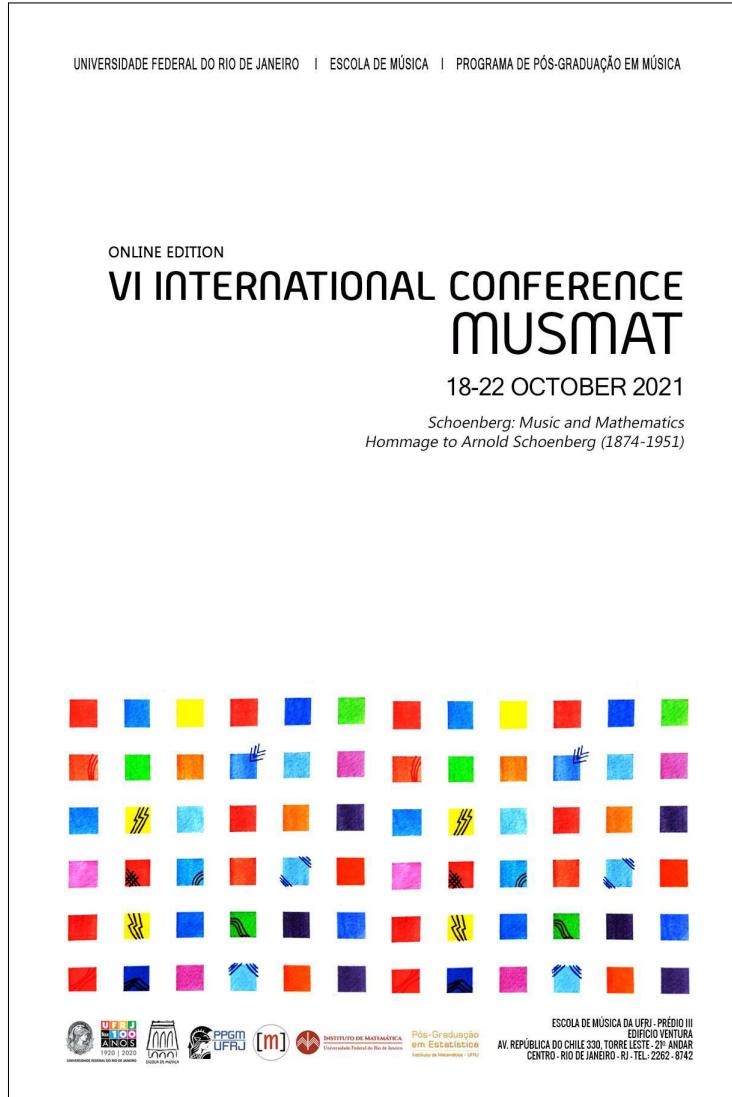


Figure 8: Poster of the 2021 MusMat Conference

- Second day (Oct/19/2021):
  - Round table 2 – "Dodecaphonism and Beyond". Participants:  
Robert Morris (Eastman School of Music) – *Form and Process in Schoenberg's Piano Piece, Opus 23, Number 3*

Sabine Feisst (Arizona State University) – *Tracing the Dissemination and Selected Manifestations of Dodecaphony, circa 1921–2021*

Gianluca Cascioli (Independent researcher) – *Alberto Colla's Concinnitas*

- Lecture, by Guilherme Bueno (Federal University of Minas Gerais), entitled *The Painter Arnold Schönberg: Transfigured Artist*
- Lecture, by Jack Boss (University of Oregon), entitled *Symmetry and the Musical Idea in Schoenberg's Op. 33a Piano Piece*
- Concert 2 – works for string quartet / "Hommage to Schoenberg (I)". Performed by the Kalimera Quartet: Luísa de Castro (1<sup>st</sup> violin), Tomaz Soares (2<sup>nd</sup> violin), Daniel Albuquerque (viola), Daniel Silva (cello)
  - \* *Rondó alla Carioca* (Carlos Almada)
  - \* *Plate Three: Hemera*, Op. 263 (Liduino Pitombeira)

• Third day (Oct/20/2021):

- Round table 3 – "Schoenberg and Analytical Processes". Participants:  
Ethan Haimo (Bar-Ilan University) – *Schoenberg, Mathematics, and the Fourth String Quartet*  
Severine Neff (University of North Carolina) – *Werker, Bach, Schoenberg, and Symmetry*  
Norton Dudeque (Federal University of Paraná) – *Three Motivic-Thematic Techniques by Schoenberg and their Analytical Application: Motivic unfolding, Developing Variation and Musical Prose*
- Lecture, by Edgardo Rodriguez and Alejandro Martinez (Universidad Nacional de La Plata), entitled *Schoenberg Op. 11 No. 3: Working with Tones of the Motive*
- Concert 3 – works for solo bassoon (performed by Ariane Petri)
  - \* *Vega*, Op. 295 (Liduino Pitombeira)
  - \* *Cinco variações sobre um tema (com variações) de Schoenberg* (Carlos Almada)
  - \* *Arboreal* (Daniel Moreira)

• Fourth day (Oct/21/2020):

- Round table 4 – "Schoenberg and Group Theory". Participants:  
Robert Peck (Louisiana State University) – *Schoenberg's I-Combinatorial Space*.  
Cecília Saraiva (Federal University of the State of Rio de Janeiro) – *Some Dodecaphonic Musings with Homotopy and the Fundamental Group*  
Marco Feitosa (Independent researcher) – *Schoenberg and Group Theory: An Intervallic Approach to Tone Rows, Symmetry and Combinatorially*
- Lecture, by Jeffrey Perry (Louisiana State University), entitled *Grace and Clarity: Schoenberg's Other School*
- Concert 4 – InterBrasilis Trio: Wladislaw Kreinski (flute), Jonatas Weima (saxophone), and Glenda Carvalho (cello)
  - \* *Arcturus*, Op. 262 (Liduino Pitombeira)
  - \* *Belo Monte* (Carlos Almada)

• Fifth day (Oct/22/2021):

- Round table 5 – "Schoenberg and Set Theory". Participants:  
Marcelo Birck (Federal University of Santa Maria) – *Multimedia Collective Creation based on an Analysis of Arnold Schoenberg's Op. 6/19: A Pedagogical Experience*  
Ricardo Bordini (Federal University of Maranhão) – *Numbers in Schoenberg's Colors*  
Luigi Verdi (Conservatorio Santa Cecilia di Roma) – *Tiling Six-Part Double Canons on Trichords*

- Lecture, by Dominik Šedivý (Richard Strauss Institut), entitled *Harmonic Schemata in Contrapuntal Composition after Hauer and Steinbauer*
- Concert 1 – works for piano / "Hommage to Schoenberg (III)" (performed by Maria Di Cavalcanti, Tamara Ujakova, and Cristiano Vogas)
  - \* *Nocturne Op. 266* (Liduino Pitombeira)

### III. MUSMAT JOURNAL

The *MusMat • Brazilian Journal of Music and Mathematics* (or MusMat Journal) was idealized by Liduino Pitombeira, Pauxy Gentil-Nunes, Daniel Moreira, and Carlos Almada in 2016. Its first number was issued at the end of that year, becoming a regular publication (two annual editions) in 2018. Since then, the journal has been counted with a considerable number of contributors, whose articles involved a wide spectrum of themes and approaches, especially connected with the use of mathematical concepts and models applied to musical analysis and composition, as well as to ground original theoretical formulations.

The next subsections present a basic overview of these articles, considering their authors and subjects.<sup>2</sup>

#### i. Volume I / number 1 (December, 2016)

Eight articles inaugurated this initial volume. The opening article of the journal was significantly written by Carlos Almada, the leader of the MusMat group. In this article, titled *Evolutionary Variation Applied to the Composition of CTG, for Woodwind Trio*, Almada integrates a broad research on musical variation introducing the original concept called "evolutionary variation", which is a convergence of Schoenbergian principles of Grundgestalt and developing variation and some ideas from Genetics and Evolutionary Biology. The concept is applied in a compositional system (Gr-S) resulting in an original piece for woodwind trio, which was premiered during the 2017 conference. The second article, *Teaching Atonal and Beat-Class Theory, Modulo Small*, was written by Richard Cohn. This paper advances a pedagogical program that models small cyclic systems before teaching the twelve-element chromatic system of atonal theory. In the third article, *Music as a Carbon Language: A Mathematical Analogy and its Interpretation in Biomusicology*, Gabriel Pareyon hypothesizes that music is more a feature and a consequence of chemical and biological constraints (not exclusive of humans), than a product "purely social" or "uniquely cultural". The fourth article, *All-(Generalized-) Interval(-System) Chords*, written Robert Peck, surveys the all-interval chords of small order and the interval systems in which they are situated, observing that these chords belong to three categories of difference sets from the field of combinatorics:  $(v, k, 1)$  planar difference sets,  $(v, k, 2)$  non-planar difference sets, and  $(v, k, 1, t)$  almost difference sets. The fifth article, *On the Relation of Quality and Quantity in the Context of Musical Composition*, by Alexandre Reche e Silva, aims to highlight the connection between quality and quantity, from a musical point of view, by sketching a typology of musical qualities and presenting the J-Syncker, an assistant software for the generation of pre-compositional material. In the sixth article, *Contour Algorithms Review*, Marcos da Silva Sampaio and Pedro Kroeger present some problems of two Music Contour Relations Theory operations algorithms (one by Rob Schultz and the other by Elizabeth Marvin and Paul Laprade) and propose two alternative algorithms to solve these problems. The seventh paper, *Sound Shizuku Composition: a Computer-Aided Composition System for Extended Music Techniques*, by Ivan Eiji Simurra and Jônatas Manzolli, discusses a new environment

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<sup>2</sup>Through a partial reproduction of the respective number's foreword.

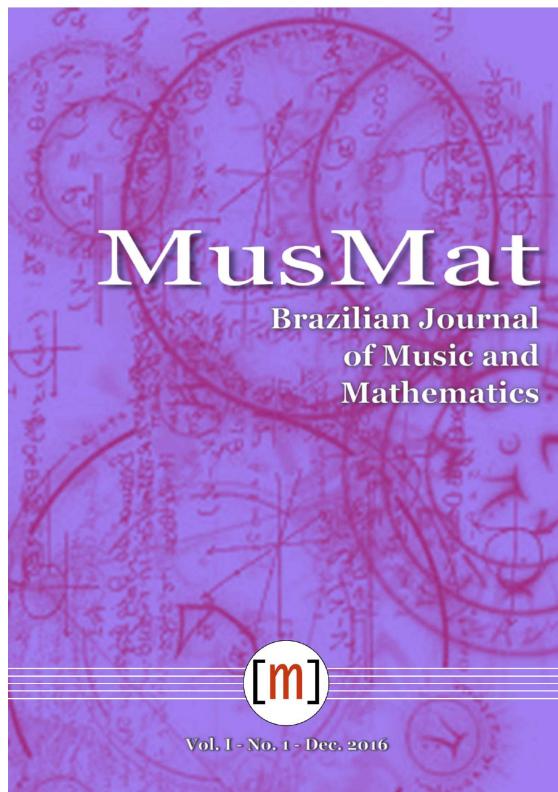


Figure 9: Cover of the inaugural edition, v.1 n.1, published in 2016.

for computer aid musical composition which is designed to create works centered on the creative use of instrumental extended techniques. The last article, *Discrete and Combinatorial Mathematics, Geometry and Mathematics of Continuous Functions Used in Some of my Compositional Projects*, by Rodolfo Coelho de Sousa, intends to demonstrate the different ways many of his compositional projects used mathematical tools, from the pre-compositional stage through a final product done with sound synthesis.

Table of contents:

- *Evolutionary Variation Applied to the Composition of CTG, for Woodwind Trio*, by Carlos Almada
- *Teaching Atonal and Beat-Class Theory, Modulo Small*, by Richard Cohn
- *Music as a Carbon Language: A Mathematical Analogy and its Interpretation in Biomusicology*, by Gabriel Pareyon
- *All-(Generalized-) Interval(-System) Chords*, by Robert Peck
- *On the Relation of Quality and Quantity in the Context of Musical Composition*, by Alexandre Reche e Silva
- *Contour Algorithms Review*, by Marcos da Silva Sampaio and Pedro Kroeger
- *Sound Shizuku Composition: a Computer-Aided Composition System for Extended Music Techniques*, by Ivan Eiji Simurra and Jônatas Manzolli
- *Discrete and Combinatorial Mathematics, Geometry and Mathematics of Continuous Functions Used in Some of my Compositional Projects*, by Rodolfo Coelho de Sousa

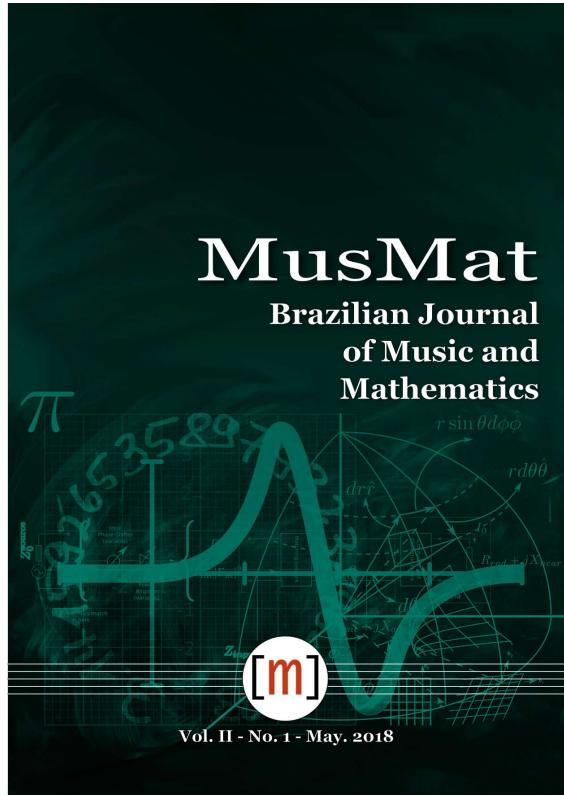


Figure 10: Cover of the second issue, v.2 n.1, published in 2018.

## ii. Volume II / number 1 (May, 2018)

After a gap in 2017, the second volume of MusMat Journal was released in 2018, presenting seven articles addressing different aspects of the various intersections between music and mathematics. In the first article, Guilherme Bertissolo discusses the idea of cycle and its various approaches within music theory to propose further compositional applications of it. Charles de Paiva presents a model for computational assisted-analysis that uses deterministic algorithms to reconstruct and simulate neighboring variants of existing musical scores. This methodology is demonstrated in the analysis of Steve Reich's *Clapping Music*. Luigi Irlandini discusses the context in which number and proportion relate to musical form in his own compositional practice considering concepts of mythic cosmologies. Luka Marohnić demonstrates how Hans van der Laan's plastic number can be used as a methodological approach to investigate the ratios between lengths of the vital parts of a sonata-form movement in a probabilistic perspective to determine the restrictions that are inherent to the temporal structure of the Eighteenth-Century Sonata form. This methodology is empirically applied to the set of sonata-form movements from the instrumental pieces of Mozart. Pauxy Gentil-Nunes discusses the way a given referential textural configuration, expressed in the form of an integer partition, can be presented by a composer in a piece in such a way that the various contiguous textures are understood as internal deviations of the referential partition, forming a hierarchical structure called Partitional Complex. Dmitri Tymoczko proposes an iterable voice-leading schema that enables the analysis of a wide range of repeating musical patterns in different repertoire. Finally, Didier Guigue presents the analysis of Webern's orchestration in his *Variationen Op. 30* by mapping all sonic resources used in the piece and the way they are combined

in different setups in the orchestral design.

Table of contents:

- *Cycles in Music: Spaces, Experience and Applications in Music Theory and Composition*, by Guilherme Bertissolo
- *Rudiments of Simulation-Based Computer-Assisted Analysis Including a Demonstration with Steve Reich's Clapping Music*, by Charles de Paiva
- *Cosmicizing Sound Music — Cosmos — Number*, by Luigi Antonio Irlandini
- *A Study of Variation in Temporal Structure of Sonata Form*, by Luka Marohnić
- *Nestings and Intersections between Partitional Complexes*, by Pauxy Gentil-Nunes
- *Iterable Voice-Leading Schemas*, by Dmitri Tymoczko
- *The Function of Orchestration in Serial Modus: The Case of Webern's Variations Op. 30 and a Proposal of Theoretical Analysis*, by Didier Guigue

### iii. Volume II / number 2 (December, 2018)

In this issue, Robert Peck presents his keynote lecture given at the 3rd National Conference of Music and Mathematics entitled *The State of the Art: New Directions in Music and Mathematics*, in which he covers the most recent trends in the convergent fields of music and mathematics, highlighting the formation of the Journal of Mathematics and Music, co-founded by the author in 2007. Ciro Visconti proposes a new approach for the representation of any contextual inversion operations between members of any set class. Liduino Pitombeira discusses the theoretical basis of the analytical-compositional methodology called Systemic Modeling, using Debussy's Prélude No.1 as a case study. Marco Sampaio proposes two new algorithms for melodic contour similarity that can be used with small and large contours. Robert Morris' article addresses two important issues in Pitch-Class Set Theory: *Z-Related Hexachords explained by Transpositional Combination and the Complement Union Property*.

Table of contents:

- *The State of the Art: New Directions in Music and Mathematics*, by Robert Peck
- *Axis of Contextual Inversion*, by Ciro Visconti
- *A Systemic Model for Debussy's Prélude No.1*, by Liduino Pitombeira
- *Contour Similarity Algorithms*, by Marcos da Silva Sampaio
- *Z-Related Hexachords explained by Transpositional Combination and the Complement Union Property*, by Robert Morris

### iv. Volume III / number 1 (June, 2019)

This issue contains a paper by Marianthi Bozapalidou that introduces a machine model to describe fundamental music functions, such as transposition, inversion, retrograde, change of durations, pitch-class distribution, and move function. Guerino Mazzola proposes a mathematical construction of musical time, derived from mathematical gesture theory and examines its application to free jazz. Daniel Moreira de Sousa formalizes the concept of textural spaces, discussing aspects on their compositional implementation through the modes of textural realization. Rael Bertarelli Gimenes Toffolo presents a computational implementation of Pousseur's harmonic network in SuperCollider computer language. Michael Winter's paper shows how James Tenney's theory of harmonic distance in harmonic space were envisioned by Leibniz more than 300 years ago.

Table of contents:

- *Machine Representation of Fundamental Musical Functions*, by Marianthi Bozapalidou

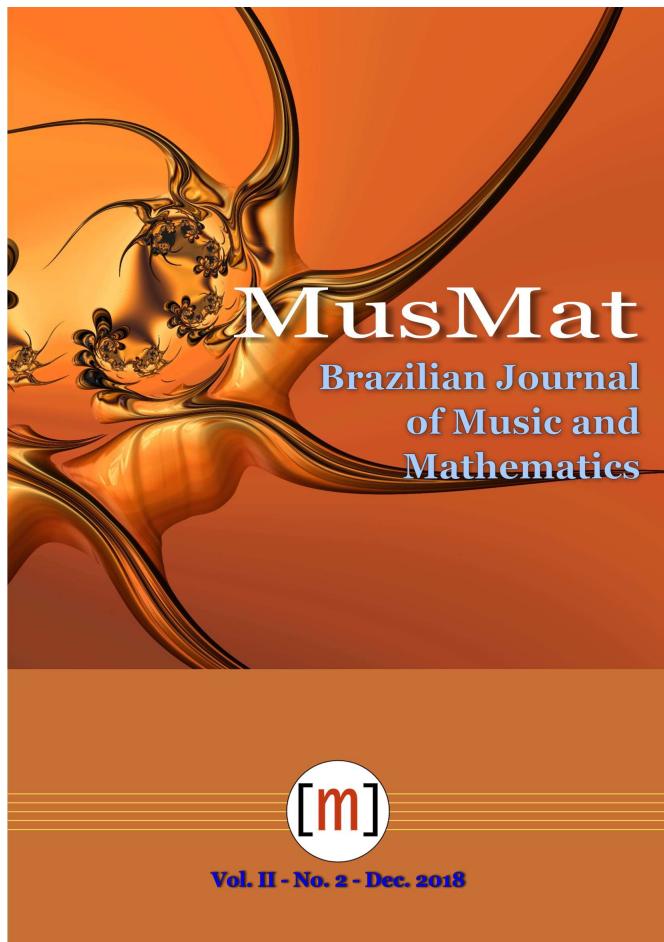
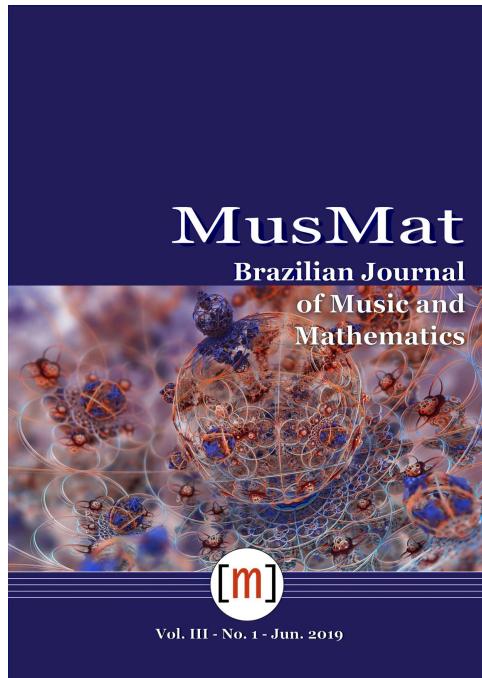


Figure 11: Cover of the third issue, v.2 n.2 published in 2018.

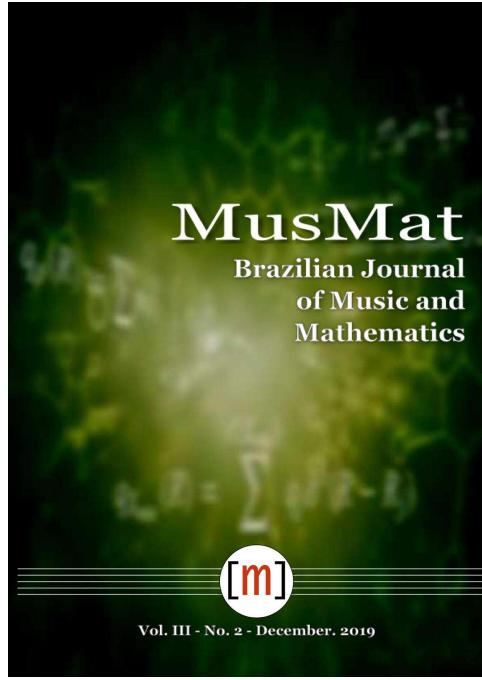
- *Musical Time: A Gestural Construction*, by Guerino Mazzola
- *Composing with Textures: A Proposal for Formalization of Textural Spaces*, by Daniel Moreira de Sousa
- *Computational Implementation of Henry Pousseur's Harmonic Networks applied to Live-Electronic Music*, by Rael Bertarelli Gimenes Toffolo
- *A Few More Thoughts about Leibniz: The Prediction of Harmonic Distance in Harmonic Space*, by Michael Winter

#### v. Volume III / number 2 (December, 2019)

David Clampitt presents an overview of Scale Theory via combinatorics on words, particularly the interaction between notes and words. Hugo Tremonte de Carvalho presents a music-oriented introduction to Markov chains and their application to music composition and analysis. Stephen Guerra's paper examines the relationships between solo and timeline rhythmic structures of Afro/diasporic musics, presenting four techniques to understand some Baden Powell's solos as cycles of a samba timeline. Carlos Almada reformulates the basic structure of a recursive algorithm proposed by Douglas Hofstadter in order to introduce transformational-musical tools. Adolfo

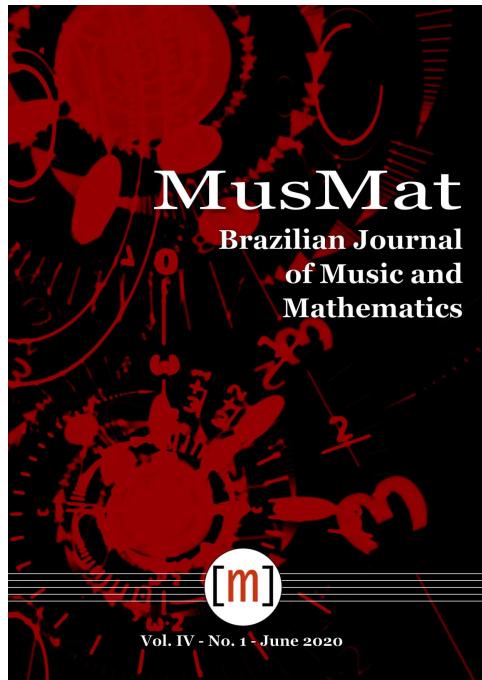


**Figure 12:** Cover of the fourth issue, v.3, n.1, published in 2019.



**Figure 13:** Cover of the fifth issue, v.3 n.2, published in 2019.

Maia and Igor Maia present an analysis of Ligeti's *Musica Ricercata I* and II on a perspective of Information Theory and Complexity, including some of Ligeti's techniques of texture.



**Figure 14:** Cover of the sixth issue, v.4 n.1, published in 2020.

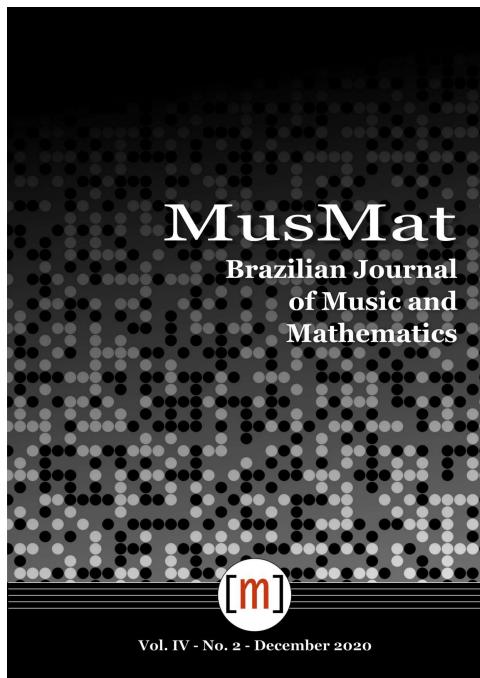
Table of contents:

- *An Overview of Scale Theory via Word Theory: Notes and Words, Commutativity and Non-Commutativity*, by David Clampitt
- *An Introduction to Markov Chains in Music Composition and Analysis*, by Hugo Tremonte de Carvalho
- *Toward a Theory of Structuring Rhythm in Improvisation in Timeline-Based Musics*, by Stephen Paul Guerra
- *PBach and Musical Transformations*, by Carlos Almada
- *An Information Theory Based Analysis of Ligeti's Musica Ricercata: Movements I and II*, by Adolfo Maia Jr. and Igor L. Maia

vi. Volume IV / number 1 (June, 2020)

Five articles integrate this number, covering diversified aspects from the rich confluence of musical and mathematical subjects. A study by Scott Murphy opens the issue, presenting an original approach of common-time meter, based on the properties of the correlate functions of metric weight and onset frequency. Jean-Pierre Briot examines deep-learning theory and techniques under the standpoint of autoencoder architectures, used for enhancing the compression of information for musical composition. Liduino Pitombeira presents a quite comprehensive survey concerning compositional systems, including the processes related to systemic modeling. Arthur Kampela discusses profoundly the processes associated with the Micro-Metric Modulation Theory. Marianthi Bozabalidou addresses the Theory of General Scale Systems through the prisms of algebraic groups, which involves the ideas of counterpoint groups and counterpoint spaces.

Table of contents:



**Figure 15:** Cover of the seventh issue, v.4, n.2, published in 2020.

- *Common Rhythm as Discrete Derivative of Its Common-Time Meter*, by Scott Murphy
- *Compress to Create*, by Jean-Pierre Briot
- *Compositional Systems: Overview and Applications*, by Liduino Pitombeira
- *Rhythm and Entropy: The Exile of the Metric in the Deviation of the Pulse*, by Arthur Kampela
- *Scales, Counterpoint Triples and their Groups*, by Marianthi Bozapalidou

#### vii. Volume IV / number 2 (December, 2020)

Six original articles integrate this number. Marco Feitosa introduces the concept of *partitional harmony*, an original field of research that relates the Theory of Integer Partitions to several fields of Post-Tonal Theory. Robert Morris provides an in-depth analysis of Feldman's *Last Pieces* for piano solo, bringing to light information that can help the pianists perform the cancelling effect requested by the composer. Gabriel Pareyon combines Matthai philosophy with Category Theory, using Yoneda lemma, suggesting that the latter can support a robust philosophy of music within the scope of Category Theory. Robert Peck investigates the inversion operation, in terms of cycles, and its application to a dramaturgical context, through the examination of the Aristotelian concept of *peripeteia*, as observable in Birtwistle's opera *Punch and Judy*. Paulo de Tarso Salles explores Forte's Genera Theory (as well as other proposals that deal with similarities between pitch-class sets) and demonstrates the application of this theory in some works by Villa-Lobos. Pauxy Gentil-Nunes discusses the *partitioning complexes* and their application in musical practice by examining three situations: textural planning in the context of compositional processes, observation of the relationship between textural configurations and coupling of the body (performative partitioning), and spatial partitioning.

Table of contents:

- *Partitional Harmony: The Partitioning of Pitch Spaces*, by Marcos Feitosa
- *Aspects of Performance Practice in Morton Feldman's Last Pieces*, by Robert Morris
- *Philosophical Sketches on Category Theory Applied to Music-Mathematical Polar Semiotics*, by Gabriel Pareyon
- *Time and Reversal in Birtwistle's Punch and Judy*, by Robert W. Peck
- *Voice Leading Among Pitch-Class Sets: Revisiting Allen Forte's Genera*, by Paulo de Tarso Salles
- *Reading Textural Functions, Instrumental Techniques, and Space Through Partition Complexes*, by Pauxy Gentil-Nunes

### viii. Volume V / number 1 (June, 2021)

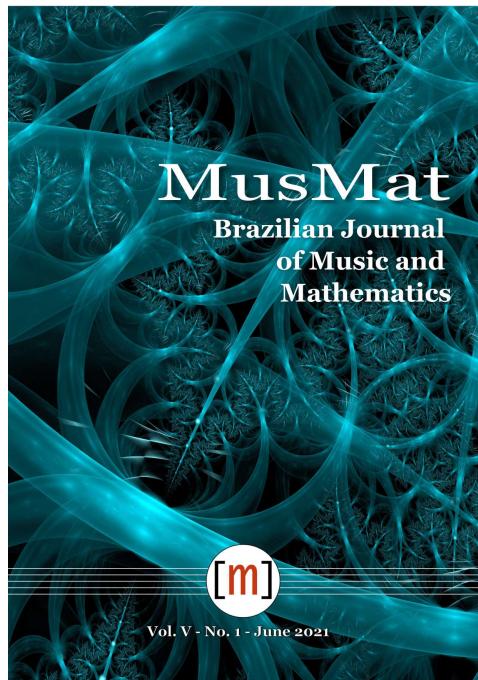
This issue comprises seven papers, that present the results of original and innovative research in the field. The number opens with a work by Robert Peck, where he applies the power group enumeration theorem to extend the Theory of Beat-Class Sets by also considering rhythms with more than one voice. Next, Gideon Effiong shows how quasigroups can be used as a unifying framework to describe musical objects and events, such as chord inversions,  $n$ -tone composition charts, and melodic motions. Ciro Visconti then discusses how Graph Theory can be used to describe all classes of trichords and tetrachords in Neo-Riemannian Theory, expanding beyond triads and seventh chords. Francisco Aragão presents an application of *Kripke semantics* to identify if a sequence of chords constitutes or not a tonal progression, which can be used to create a software to benefit students that do not have easy access to a harmony teacher. Subsequently, Juan Sebastián Arias-Valero and Emilio Lluis-Puebla develop deep relations and philosophical reflections between Gesture Theory and Category Theory. Next, Silvio Ferraz describes a series of patches in Max/MSP environment tailored to aid musical analysis and composition and exemplifies it with the composition of a piece based on Brahms' Op. 119. The issue closes with Daniel Moreira introducing the concept of *compositional entropy*, which deals with the amount of freedom of a composer when dealing with compositional choices, and such a concept is demonstrated in musical texture.

#### Table of contents:

- *Beat-Class Set Classes and the Power Group Enumeration Theorem*, by Robert W. Peck
- *Musical Quasigroups*, by Gideon Okon Effiong
- *Neo-Riemannian Graphs Beyond Triads and Seventh Chords*, by Ciro Visconti
- *Tonal Progressions Identification Through Kripke Semantics*, by Francisco Erivelton Fernandes de Aragão
- *A Conceptual Note on Gesture Theory*, by Juan Sebastián Arias-Valero and Emilio Lluis-Puebla
- *Modeling, Listening, Analysis, and Computer-Aided Composition*, by Silvio Ferraz Mello Filho
- *Measuring the Amount of Freedom for Compositional Choices in a Textural Perspective*, by Daniel Moreira

### ix. Volume V / number 2 (December, 2021)

This issue presents five articles discussing different aspects of the intersection between music and mathematics. Juan Sebastián Arias-Valero, Octavio Alberto Agustín-Aquino, and Emilio Lluis-Puebla present a theoretical description of a model based on the generalization of first-species counterpoint considering arbitrary rings, which results in a broader mathematical theory for contrapuntal intervals. Carlos Mathias and Carlos Almada introduce an original proposal to encode timelines as univocal integers by using arithmetic mapping so that drum-set timelines are encoded by using Gödel's Numbering algorithm. Paul Lombardi presents an interesting discussion

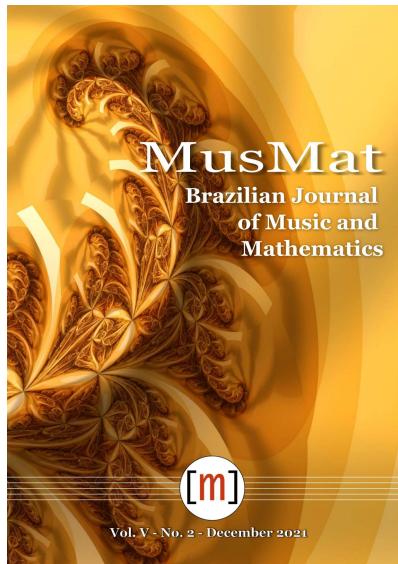


**Figure 16:** Cover of the eighth issue, v.5 n.1, published in 2021.

on feathered beams, examining their concept and notation to propose a graphing system to deconstruct them using examples from George Crumb's *Night Music* I. Hugo Carvalho proposes a new tool for performing time-frequency analysis on audio signals, the probabilistic spectrogram, that may allow for probabilistic interpretations related to the Discrete Fourier Transform and also the creation of new features for audio signal processing and music information retrieval. Finally, Juan Sebastián Arias-Valero and Emilio Lluis-Puebla present a specific and didactic application for gestural presheaves in the language of abstract gestures, dealing specifically with the relation thereof to the Yoneda embedding and Mazzola's idea and gestural sheaves, demonstrating the application in Mozart and Beethoven. In this issue, we are also glad to inaugurate a new section with an interview with Severine Neff, discussing her work on Schoenberg's music and theory.

Table of contents:

- *On First-Species Counterpoint Theory*, by Juan Sebastián Arias-Valero, Alberto Agustín-Aquino, and Emilio Lluis-Puebla
- *Prime Decomposition Encoding: An Analytical Tool by the Use of Arithmetic Mapping of Drum-Set Timelines*, by Carlos Mathias and Carlos Almada
- *Feathered Beams*, by Paul Lombardi
- *Toward a Probabilistic Fourier Analysis on Audio Signals*, by Hugo Tremonte de Carvalho
- *Gestural Presheaves: From Yoneda to Sheaves*, by Juan Sebastián Arias-Valero and Emilio Lluis-Puebla
- Interview with Severine Neff



**Figure 17:** Cover of the ninth issue, v.5 n.2, published in 2021.

#### IV. MusMAT LECTURES

In 2019, the MusMat Group started a series of encounters, in which renowned researchers from different fields presented in-person lectures. Three lectures were held (Figs. 25, 26, and 27): the first one by Jean-Pierre Briot entitled *Revisitando a criação de conteúdo musical com técnicas recentes de aprendizagem profunda* (*Revisiting the creation of musical content with recent techniques of deep learning*); the second and third lectures were part of the preparation for a course given by MusMat Group, on the work *Formalized Music*, by Iannis Xenakis, in partnership with four professors in the mathematical field, within the scope of the Graduate Program in Music at UFRJ: Hugo Carvalho, Nei Rocha, Petrucio Viana, and Stafanella Boatto. Thus, Hugo Carvalho presented a lecture entitled *Cadeias de Markov aplicadas à composição musical* (*Markov Chains applied to musical composition*) and Petrucio Viana discussed the 6<sup>th</sup> Chapter of Xenakis' book. In 2020, due to the COVID-19 pandemic, the lectures took a break, but it is a project that the group will regularly resume in 2023.

#### V. MusMAT PODCAST

To reach non-specialist teachers and younger students, the MusMat Group created the *MusMat Podcast*, the first podcast in Brazil that specifically offers content in Portuguese, about Music and Mathematics. The MusMat Podcast is hosted by Carlos Mathias and Hugo Carvalho and each episode consists of an interview with a guest, a specialist, teacher and researcher of the area. The episodes are available in audio format at <https://anchor.fm/musmat-podcast> and in video format at our YouTube channel <https://www.youtube.com/c/musmat>. Among the guests interviewed so far are Cecília Saraiva, Daniel Moreira, Carlos Almada, Hugo Carvalho, Liduino Pitombeira, Marco Feitosa, and Jack Boss (Figs. 18, 19, 20, 21, 22, 23, 24). The MusMat Podcast will start producing other kinds of content soon, such as videos of short duration, informal enough to be used on music/mathematics classes of Brazilian junior and high schools, hopefully.

## VI. FUTURE PROJECTS

Up to this point, the projects of the MusMat Group were directed mostly to research and teaching at Master and Doctorate level. One of our main goals from now on is to propagate the connections between music and mathematics to the undergraduate scenario, as well as to the community overall. A first step on this direction is the organization of a book with articles that contain or explain further details of each talk from the lectures and round tables that occurred during the Musmat Conference of 2021, which was a homage to Arnold Schoenberg and his legacy. We have asked the speakers to write or publish the content of their ideas in a volume that is being organized by the MusMat Group. Some texts are articles that were previously written but not published and some are fresh new, so that every text is original. We've had a lot of great talks and wanted to make them known to a wider range of people.

There are many books written in English and other languages about music and mathematics, such as David Wright's *Music and Mathematics* and Gareth Loy's *Musimathics*. Unfortunately, when the language in hand is Portuguese, finding books (or even introductory notes) about music and mathematics is a very hard task. This unavailability affects not only the brazilian students who lack proficiency in English, but also dampens the divulgence of more complex relations between music and mathematics to the common sense, that lay beyond acoustics/undulatory phenomena, for instance. One of our most cherished future projects also follows the trend of inclusion: a joint book written in Portuguese, that presents the basic elements of the area of music and mathematics and that explores its elementary and modeling properties and aspects.

We are also looking forward to having an expansion of the MusMat Group project that we call *Musmatinho* (little MusMat, translating from Portuguese), which is meant to be a gathering of MusMat, students and interested people who are not officially part of the research group, but may contribute with their ideas, creativity and enthusiasm. We've already had one meeting in which Doctorate, Post-Doctorate, Master, undergraduate and former students from both Music and Mathematics courses presented their interests, so we could get to know each other. Our aim is to grow our collaborative network and broaden students' perspectives toward the areas.



Figure 18: Poster of the first MusMat Podcast, with Cecília Saraiva (available at <https://youtu.be/imszzsY0eza>).



**Figure 19:** Poster of the second MusMat Podcast, with Daniel Moreira (available at <https://youtu.be/YuXhyFtPFCs>).



**Figure 20:** Poster of the third MusMat Podcast, with Hugo Carvalho (available at <https://youtu.be/nuXDXJ08Quc>).



**Figure 21:** Poster of the fourth MusMat Podcast, with Carlos Almada (available at <https://youtu.be/b02AbtxYcik>).



**Figure 22:** Poster of the fifth MusMat Podcast, with Liduino Pitombeira (available at [https://youtu.be/5VET-Eks\\_-E](https://youtu.be/5VET-Eks_-E)).



**Figure 23:** Poster of the sixth MusMat Podcast, with Marco Feitosa and Cecília Saraiva (available at <https://youtu.be/fuxHT-Y8AO4>).



**Figure 24:** Poster of the sixth MusMat Podcast, with Jack Boss (available at <https://youtu.be/30BGDhKfqoY>).

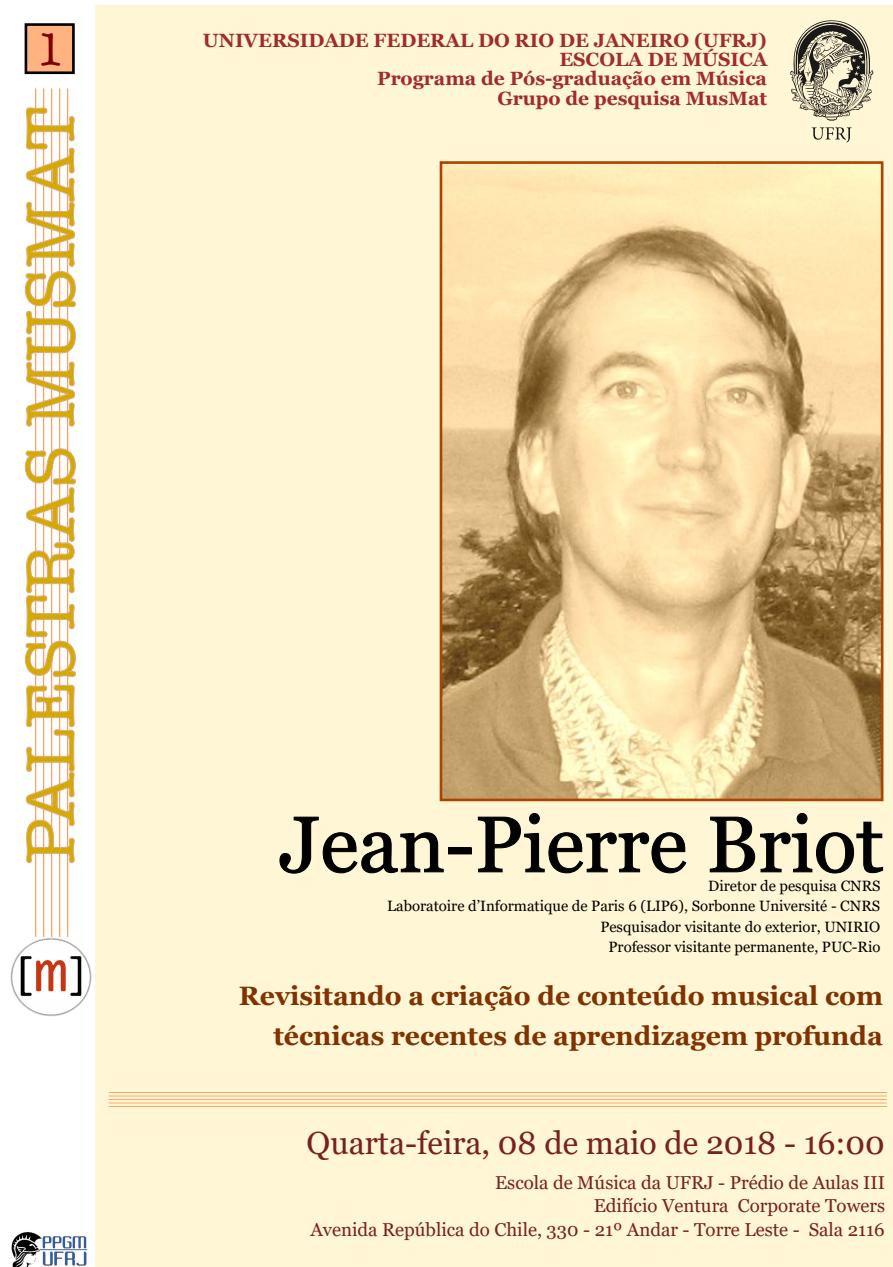


Figure 25: Poster of the first MusMat Lecture, by Jean-Pierre Briot.



**Figure 26:** Poster of the second MusMat Lecture, by Hugo Carvalho.

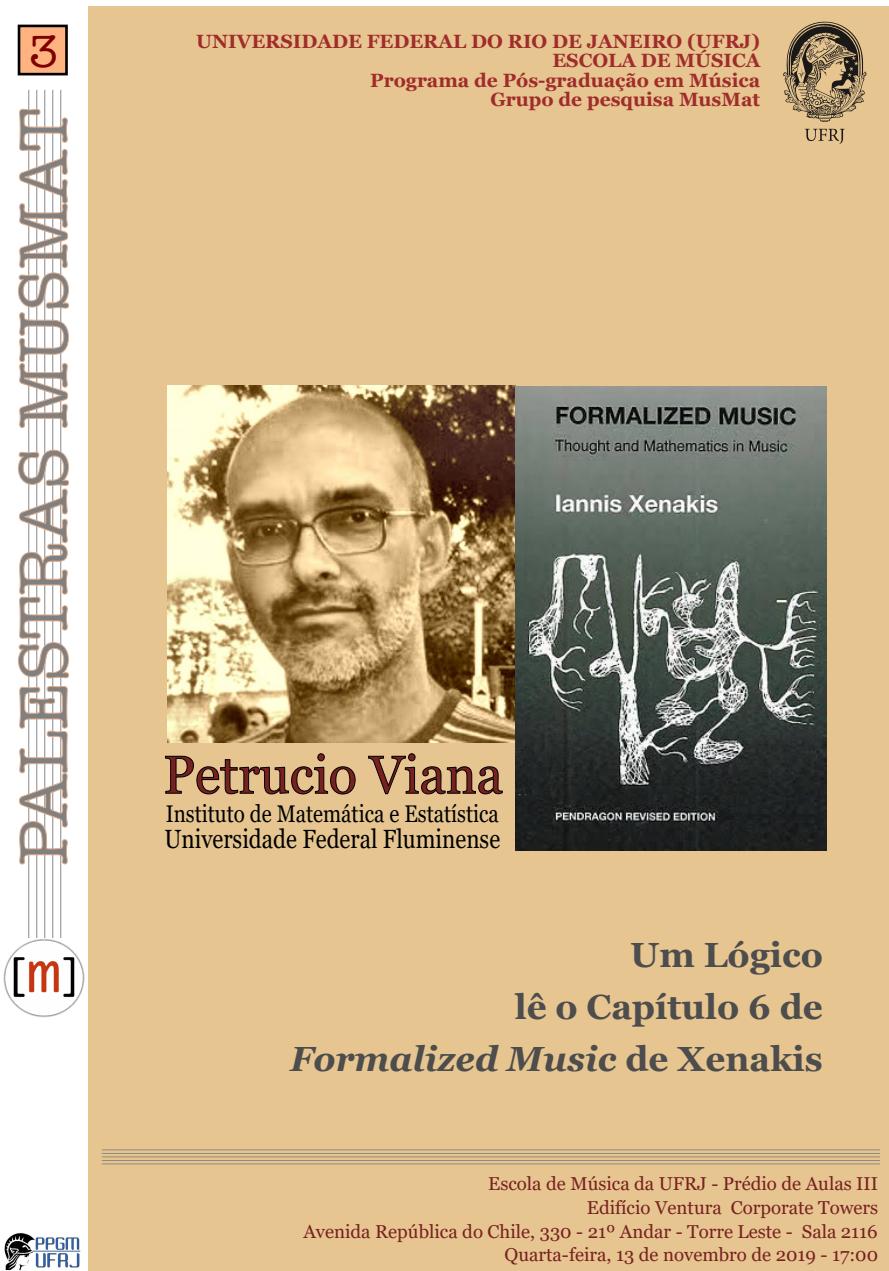


Figure 27: Poster of the third MusMat Lecture, by Petrucio Viana.