Women in Algebraic and Geometric Topology, Dynamical Systems and Evolution Algebras

Caderno de Resumos

(Abstract of Talks and Posters)

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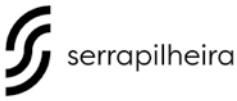

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Sumário (Contents)

Palestras (Talks)

Problems on Algebraic and Geometric Topology and Applications

Denise de Mattos*
Universidade de São Paulo, ICMC-USP (SP-Brasil)

This research project consists of exploring the following themes in Algebraic Topology:

(1) **On the self-intersection set of continuous maps and Gysin sequences:**

This project aims to study the self-intersection set of continuous maps between general topological spaces via Gysin exact sequences.

Authors (1): Alice Kimie Miwa Libardi, Carlos Biasi, Denise de Mattos and Edivaldo Lopes dos Santos.

(2) **Parameterized versions of the Borsuk-Ulam Theorem:**

The aim of this project is to obtain new parameterized versions of the Borsuk-Ulam Theorem, in the sense of Dold.

Authors (2): Denise de Mattos, Edivaldo Lopes dos Santos and Leandro Vicente Mauri

*Partially supported by FAPESP, process numbers 2025/22919-3 and 2022/16455-6 (Projeto Temático: Algebraic, Geometric and Differential Topology).

A relationship between Bordism and L–equivalence

Alice Kimie Miwa Libardi*
Universidade Estadual Paulista, IGCE-UNESP (SP-Brasil)

The aim of this work is to establish a relationship between $\Omega_k(N)$ and the set $L_k(N)$ of L-equivalence classes of oriented k-dimensional submanifolds of a compact oriented manifold N.

Authors: Alice Kimie Miwa Libardi, Carlos Biasi, Denise de Mattos and Edivaldo Lopes dos Santos

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On Artin Representation Types and Algebraic Properties for Surface Generalized String Links

Juliana Roberta Theodoro de Lima
Universidade Federal de Alagoas, IM-UFAL (AL-Brasil)

This research project aims to investigate classes of Artin-type representations and their associated algebraic structures, with particular emphasis on orderability properties of generalized string-links on surfaces. We consider both orientable and non-orientable surfaces, either closed or with boundary, and analyze how the topology of the underlying surface influences the algebraic behavior of these groups. The project seeks to contribute to a deeper understanding of the interplay between braid-type groups, surface topology, and group orderability, providing new structural results and potential applications within geometric and combinatorial group theory.

Authors *: This research project is being carried out by Alice Libardi (UNESP-Rio Claro), Denise de Mattos (ICMC-USP) and Juliana Theodoro (IM-UFAL), with international collaboration of Adam Clay (University of Manitoba).

*Partially supported by Committee for Women in Mathematics of the International Mathematical Union (CWM-IMU) and FAPESP, process numbers 2025/22919-3 and 2022/16455-6 (Projeto Temático: Algebraic, Geometric and Differential Topology).

Evolution algebras and Graphs: an introduction

Mary Luz Rodiño Montoya*
Universidad de Antioquia, IM-UdeA (ANT-Colômbia)

Recently, a significant number of results on Evolution Algebras have been presented in the literature. This type of non-associative algebra was introduced by Tian and Vojetchovsky in 2006 in their paper "Mathematical Concepts of evolution algebras in non-Mendelian genetics". Two years later, Tian published the book Evolution algebras and their applications (2008), in which he expands on the theory of evolution algebras, their relationship with other areas (biology, physics, probability, among others) and leaves several problems to be addressed. In this lecture, we will present the basic concepts of this theory and the results that our working group has obtained in recent years, which address the study of evolution algebras not only with tools from non-associative algebras and linear algebra, but also, for example, with other tools provided by group theory and graph theory.

*Partially supported by Committee for Women in Mathematics of the International Mathematical Union (CWM-IMU).

Derivations of evolution algebras

Paula Andrea Cadavid Salazar *
Universidade Federal Rural de Pernanbuco, DMAT-UFRPE (PE-Brasil)

In this talk, we will define the concept of a derivation of an algebra (in particular, of an evolution algebra) and present some of the results available in the literature concerning these operators, with special emphasis on those that explore the connection between this type of algebra and certain classes of graphs, both directed and undirected.

To conclude, we will present some open problems that we intend to address during the workshop.

*Partially supported by Committee for Women in Mathematics of the International Mathematical Union (CWM-IMU).

Local Derivations of Evolution Algebras

Sandra Maria Zapata Yepes *
Universidade Federal do ABC, CMCC-UFABC (SP-Brasil)

Local derivations are linear operators defined on an algebra that, for each element, coincide with some derivation, which may vary from one element to another. This concept was introduced in 1990 by Kadison, as well as by Larson and Sourour, in the context of Banach algebras and modules. Since then, local derivations have been widely investigated in various types of algebras, including Lie algebras and Jordan algebras .

Recently, Farrukh, Otabek, Bakhrom, and Izzat obtained a complete characterization of local and 2-local derivations in nilpotent evolution algebras. In this paper, we present a brief introduction to these results, discussing their main implications and highlighting some open questions. In particular, although every derivation is a local derivation, the reciprocal is not always true. Thus, the following problem naturally arises:

Determine for which classes or families of Evolution Algebras the notions of derivation and local derivation coincide.

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A Free Action approach to Evolution Algebras Automorphisms

Natalia A. Viana Bedoya*
Universidade Federal de São Carlos, DM-UFSCar (SP-Brasil)

Given an evolution algebra associated to a finite, connected graph, we exhibit a free action of the group of symmetries of the graph on the set of automorphisms of the algebra. This enables us to identify evolution algebras with a finite automorphism group based on weaker hypotheses than those found in current literature.

We explore our result in two directions:

(1) A possible characterisation of the orbit space;
(2) A possible extension of this type of result to Cayley graphs.

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Topological Persistence of Circular Maps and Applications in the Dynamics of Vector Fields

Dahisy Valado de Souza Lima *
Universidade Federal do ABC, CMCC-UFABC (SP-Brasil)

Thais Fernanda Monis *
Universidade Estadual Paulista, IGCE-UNESP (SP-Brasil)

A theory of topological persistence for circular mappings has been developed over the last decade. In this project, we propose studying the topological persistence invariants for circular mappings already established in the literature, as well as exploring potential applications in the study of the dynamics of vector fields, in the spirit of Conley Theory.

*Partially supported by Committee for Women in Mathematics of the International Mathematical Union (CWM-IMU).

Persistent Homology in Complex Cancer Networks

Cynthia de Oliveira Lage Ferreira*
Universidade de São Paulo, ICMC-USP (SP-Brasil)

Persistent homology, a fundamental tool in Topological Data Analysis, provides a multiscale framework for studying higher-order structures in complex networks. In cancer research, systems such as protein-protein interaction and mutation networks can be modeled as weighted graphs whose organization reflects functional and pathological processes.

By constructing filtrations and analyzing the evolution of topological invariants, persistent homology captures higher-dimensional features that are not detectable through traditional graph-theoretic metrics. These topological signatures reveal patterns of robustness, redundancy, and heterogeneity associated with oncogenic mechanisms.

Combined with perturbation strategies such as node removal, this approach enables the quantification of the topological impact of individual genes, offering a complementary perspective for identifying biologically relevant targets in cancer systems.

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Soybean Leaves

Thiago de Melo and Jamil Pereira
Universidade Estadual Paulista, IGCE-UNESP (SP-Brasil)

Images of soybean plants were obtained and transformed into a table, and using TDA techniques, they are being analyzed to assess changes in plant development under the effects of weather variation.

Authors*: Thiago de Melo, Jamil Pereira, Leandra Bordignon, Guilherme Vituri, Washington Mio, Alice Libardi.

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A Classification based on images of Fly Wings

Northon Penteado
Instituto de Formação de Educadores da Universidade Federal do Cariri, IFE
(CE-Brasil)

Guilherme Vituri
Appsilon, Software Development & Data Innovation Partner in Life Sciences (Polônia)

For insect groups, wing morphology is an important character for species iden- tification. In this project we are using methods from TDA (Topological Data Analysis) to obtain a classification based on images of fly wings. Images of insect wings were obtained and organized into two tables representing the wing outlines and the wing veins, using the software "Julia" and the visual Code,as an interface.

Authors*: Sergio Ura, Guilherme Vituri, Northon Penteado, Washington Mio e Alice Libardi.

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Uma caracterização dos gráfos que podem surgir como gráfos de Reeb de funções definidas em superfícies tóricas normais

Thaís Dalbelo
Universidade Federal de São Carlos, DM-UFSCar (SP-Brasil)

Carina Alves e Eliris Rizziolii
Universidade Estadual Paulista, IGCE-UNESP (SP-Brasil)

Em 2018 Lukasz Patryk Michalak investigou o problema da realizao de um grafo dado como o grafo de Reeb $R(f)$ de uma funo suave $f : M \to \mathbb{R}$ com um nmero finito de pontos crticos, onde M uma variedade fechada . Obtendo que, para qualquer $n \geq 2$ e qualquer grafo Γ que admita a chamada boa orientao, existe uma n-variedade M e uma funo de Morse $f : M \to \mathbb{R}$ tal que seu grafo de Reeb $R(f)$ isomorfo a Γ, estendendo resultados anteriores de Sharko e Matsumoto-Saeki. As variedades suaves constituem o cenrio clssico para o estudo de funes de Morse e de seus grafos de Reeb. No entanto, seria interessante estudar problemas desta natureza tambm em variedades com singularidades controladas, como as superfcies tricas normais, por exemplo. Essa classe de variedades interessante porque tais superfcies, embora no sejam suaves, possuem uma estrutura combinatria rica proveniente da ao do toro, que organiza e descreve suas propriedades de forma sistemtica. Alm disso, as singularidades presentes so suficientemente bem comportadas para que essas superfcies sejam tratadas como pseudovariedades, mantendo a possibilidade de aplicar ferramentas topolgicas e analticas. Assim, o estudo de grafos de Reeb em variedades trias normais no apenas generaliza os resultados obtidos em variedades suaves, mas tambm abre novas perspectivas de investigao, conectando topologia, geometria algbrica e combinatria.

Os objetivos especficos so:

- Desenvolver uma caracterizao dos grafos que podem surgir como grafos de Reeb de funes definidas em superfcies tricas normais.
- Utilizar a combinatria associada ao do toro para descrever e classificar problemas relacionados s variedades trias normais, estabelecendo conexes entre dados combinatrios e propriedades topolgicas.
- Comparar os resultados obtidos com os casos clssicos de variedades suaves, identificando semelhanas e diferenas fundamentais.
- Fornecer uma estrutura terica que permita futuras aplicaes em reas como geometria algbrica, topologia de grafos e teoria de Morse em espaos

Authors*: Thais Dalbelo, Denise de Mattos, Carina Alves , Eliris Rizziolli e Washington Mio.

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Topological Classification of Dissipative Systems via Reeb Graphs of Lyapunov Functions

Marco Contessoto and Renata Zotin
Universidade Estadual Paulista, IGCE-UNESP (SP-Brasil)

We propose to develop a topological framework for the qualitative classification of dissipative dynamical systems based on the Reeb graph associated with a strict Lyapunov function. Under Morse-Smale assumptions, such a function induces a canonical acyclic orientation on the Reeb graph, reflecting the monotonic decrease of the Lyapunov function along trajectories. This oriented graph encodes the global organization of the flow, with vertices corresponding to critical components and edges representing invariant regions connecting them. In particular, the orientation identifies the direction of the flow between repellers, saddles, and attractors, and describes the structure of basins of attraction and the separatrices that separate them.

In dimension two, we intend to prove that the oriented Reeb graph determines the system up to topological (orbital) equivalence. More precisely, we aim to show that, given two dissipative Morse-Smale systems on compact surfaces that admit strict Lyapunov functions, if their associated oriented Reeb graphs are isomorphic as directed graphs, then there exists a homeomorphism mapping orbits of one system onto orbits of the other while preserving their time orientation.

We also intend to examine the structural stability of this invariant, by showing that, within the class of Morse?Smale systems, perturbations that preserve the qualitative structure of the Lyapunov function do not alter the isomorphism class of the associated oriented Reeb graph. Finally, we plan to clarify the relationship between this construction and the Morse-Smale complex, showing how the oriented Reeb graph can be interpreted as a quotient representation of the global gradient-like structure, and to explore connections with related constructions in topological data analysis.

Authors*: Suzete Afonso, Marco Antonio Contessoto, Renata Zotin, Eliris Rizziolli, Washington Mio.

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Métricas em Espaços de Reeb

Edivaldo Lopes dos Santos e Luiz Hartmann
Universidade Federal de São Carlos, DM-UFSCar (SP-Brasil)

Neste projeto pretendemos provar teoremas de estabilidade de uma métrica entre Espaços de Reeb associados a espaços métricos com medida.

Authors*: Edivaldo Lopes dos Santos, Alice Libardi, Nelson Silva, Luiz Hartmann, Thiago de Melo e Washington Mio.

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Painéis (Posters)

Bi-Lipschitz Invariants in Singularity Theory: Lojasiewicz Exponent, Multiplicity, and Euler Obstruction

Amanda Santos Araújo
Universidade Federal de São Carlos, DM-UFSCar (SP-Brasil)

In this work, we investigate the bi-Lipschitz invariance of three fundamental local invariants in singularity theory: the Lojasiewicz exponent, the Hilbert-Samuel multiplicity, and the local Euler obstruction. We draw inspiration from Bivia-Ausina and Fukui, whose framework we extend to ideals in analytic spaces. We establish conditions under which these invariants remain unchanged under bi-Lipschitz equivalence. In particular, we prove a special case of the metric version of Zariski multiplicity conjecture. We show that multiplicity is preserved when the ideal coincides with the integral closure of its order ideal. We also provide a partial answer to the open question of whether the local Euler obstruction is a bi-Lipschitz invariant. For hypersurfaces with isolated singularities, we show that the Euler obstruction is preserved under non-degeneracy conditions. These results contribute to the understanding of metric invariants in complex analytic geometry. This is a joint work with Thas Maria Dalbelo and Thiago da Silva.

New extensions of Tverberg-type Theorems

Leandro Vicente Mauri
Universidade Federal de São Carlos, DM-UFSCar (SP-Brasil)

Tverberg's Theorem asserts that for any affine map $f : \Delta^N \to \mathbb{R}^d$, where $N = (r-1)(d+1)$, there exist r pairwise disjoint faces of the simplex whose images have a common point. Its topological counterpart extends this conclusion to continuous maps when r is a prime power, and constitutes a cornerstone of topological combinatorics under the name of the Topological Tverberg Theorem. In this paper, we develop new Tverberg-type results in the context of k-valued maps, providing sufficient conditions that ensure the existence of intersection properties analogous to those in the classical setting.

Representação de Enlaçamentos de Intervalos Generalizados

Juliana Roberta Theodoro de Lima
Universidade Federal de Alagoas, IM-UFAL (AL-Brasil)

Neste trabalho falaremos s brevemente sobre o Teorema da Representação de Artin para os Grupos de Tranças e suas extensões para os enlaçamentos de intervalos generalizados no disco e em superfícies.

Autoras*: Juliana Roberta Theodoro de Lima, Denise de Mattos e Alice Libardi.

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Fundamentos da Homologia Persistente

Marina Maria de Miguel*
Universidade Federal de São Carlos, DM-UFSCar (SP-Brasil)
Sérgio Rodrigues Verde Junior
Universidade Estadual Paulista, IGCE-UNESP (SP-Brasil)

A principal motivação da Análise Topológica de Dados (TDA) é a de compreender a "forma" de seus dados, partindo da premissa de que, ao fazer isso, você conseguirá extrair informações importantes a respeito deles. Uma das ferramentas mais utilizadas na TDA é a Homologia Persistente (ou de Persistência), que consiste inicialmente em uma adaptação dos conceitos de Homologia (Simplicial, Singular, etc.) para tratar de filtrações de complexos simpliciais, que são obtidos ao enxergar seu conjunto de dados como uma nuvem de pontos no $\mathbb{R}^n$. Uma característica fundamental da Homologia Persistente é a sua Estabilidade, que garante que os resultados obtidos não serão sensíveis a ruídos ou a pequenas perturbações: em outras palavras, nuvens de pontos relativamente próximas terão assinaturas topológicas relativamente parecidas. Neste trabalho, faremos um breve passeio pela construção da teoria da Homologia Persistente, entendendo seus principais aspectos, o que de fato é a estabilidade, e como a Algebra Homológica nos ajuda a obter resultados nessa area.

Bibliografia

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[2] Boissonnat, J. D.; Chazal, F.; Yvinec, M, Geometric and topological inference, Cambridge: Cambridge University Press, 2018.

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Introdução à homologia persistente para funções circulares

Nícolas Torres Matos
Universidade Federal do ABC, CMCC-UFABC (SP-Brasil)

Givanildo Donizeti de Melo
Universidade Federal do Recôncavo da Bahia, CETEC-UFRB (CE-Brasil)

A persistência topológica é uma ferramenta que estuda as características topológicas de um espaço que se mantêm ao longo de uma funçãoo, utilizando homologia persistente de nível. O objetivo deste trabalho é apresentar a noção de persistência topológica para funções tame definidas em espaos topológicos compactos, tomando valores no círculo S^1. Para estender o estudo clássico da persistência de funções reais para funções circulares, além do conhecido invariante de código de barra, será utilizado as células de Jordan, que surgem da representação de quivers circulares.

Persistence and Cancellation in circle-valued Morse theory via a spectral sequence analysis

Mariana Rodrigues da Silveira*
Universidade Federal do ABC, CMCC-UFABC (SP-Brasil)

The purpose of this work is to present a procedure in the context of Circle-Valued Morse Theory which allows us to extract dynamical and homological information from a spectral sequence. Given a circle-valued Morse function on a smooth closed 2 dimensional manifold and a corresponding filtered Novikov chain complex, the spectral sequence sweeping algorithm produces a family of matrices which encodes the information of the associated spectral sequence. These matrices keep track of all dynamical information on the birth and death of connecting orbits between consecutive critical points that could occur in a one parameter family of flows, as well as periodic orbits that may arise. In this way, these matrices give us a continuation from the initial Novikov flow to a minimal flow. A central result of this work shows that the final matrix produced by the spectral sequence sweeping algorithm contains complete information about the persistent homology: the generators, the length of each bar of the barcode. Moreover, we obtain results relating the bars in the barcode and the cancellation of critical points.

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Characterization on Nonlinear $*$-Jordan-Type Derivations on Alternative structure

Aline Jaqueline de Oliveira Andrade*
Instituto Federal de São Paulo, IFSP (SP-Brasil)

The additivity of mappings has been the subject of extensive study by mathematicians. The first surprising result is due to Martindale III, who established a condition on a ring under which multiplicative bijective mappings are additive. In this work, we present results that provide a classification of nonlinear *-Jordan n-derivations that are *-additive derivations on alternative *-algebras and applications of these results to alternative W*-factors.

*Partially supported by Instituto Nacional Serrapilheira.

Spectral Sequences and Alternanting Homology

Hana Marinho Lucena
Universidade de São Paulo, ICMC-USP (SP-Brasil)

A method for computing the homology of images of finite maps is described using spectral sequences associated with double complexes of alternating chain complexes. The resulting spectral sequence collapses, allowing the homology groups of the image to be determined from the initial pages.

Teorema de Bézout no Estudo de Singularidades

Eduarda Rodrigues Duarte
Universidade de São Paulo, ICMC-USP (SP-Brasil)

Neste trabalho, investigamos curvas algébricas em $P^2(k)$, onde k é um corpo algebricamente fechado, utilizando o Teorema de Bézout como ferramenta central. Este teorema estabelece que o número de pontos de interseção entre duas curvas projetivas planas sem componentes em comum é igual ao produto de seus graus, contando multiplicidades. Exploramos algumas aplicações importantes no estudo de singularidades: primeiro, o teorema permite identificar critérios para a irredutibilidade de curvas projetivas; em seguida, garante que o conjunto de pontos singulares de uma curva algébrica é finito; e, por fim, fornece um limite superior para o número de singularidades que uma curva plana irredutível de grau n pode apresentar. Essas aplicações destacam a utilidade do Teorema de Bézout na análise geométrica de curvas e na compreensão de suas propriedades locais e globais.

Polynomial differential systems in $\mathbb{R}^3$ having invariant weighted homogeneous surfaces

Thaís Maria Dalbelo*
Universidade Federal de São Carlos, DM-UFSCar (SP-Brasil)

In this work we give the normal form of polynomial differential systems in $\mathbb{R}^3$ having a weighted homogeneous surface $f = 0$ as an invariant algebraic surface. Using the obtained results we give some examples of stratified vector fields, when $f = 0$ is a singular surface.

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Algebraic study of graphs through evolution algebras

Manuela Bocanegra Quigua
Universidad de Antioquia, IM-UdeA (ANT-Colômbia)

For the family of Tadpole graphs and their associated evolution algebra, in the particular case where the graph consists of a cycle of four vertices, we study the relationship between the quotient graph and the directed graph associated with the square algebra, when it is of evolution. This relationship will depend on whether the graph consists of a path of even or odd length.