Report of MAP-PDMA 2021/2022
PhD in Applied Mathematics
Universities of Minho-Aveiro-Porto

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Contents

1 Introduction

The lectures of MAP-PDMA 2021/2022 (1st year) took place at the Department of Mathematics, University of Aveiro (UA). The Program received 32 applications at UA for the 1st year and accepted 24 students.

2 1st Semester

The 1st semester began October 11th, 2021.

2.1 Schedule

Lectures, otherwise indicated, took place at Room 11.3.21.

Monday	Tuesday	Wednesday	Thursday	Friday
POA: 9h00–12h00	TADG: 8h30–12h30		TAALC: 10h–12h	ED: 9h30–11h00
DMB: 11h30-13h00			TAALC: 13h–15h	TAPE: 11h–13h
DMB: 14h00–15h30	TT: 14h30–17h30	TAAO: 14h00–18h00		TAPE: 14h–16h
	TG: 15h00–18h00			SEM: 16h–18h

2.2 Professors involved

There was a total of 25 professors involved in the 1st semester, as follows: 8 from University of Minho (UM); 12 from University of Aveiro (UA); and 5 from University of Porto (UP).

2.2.1 Professors from UM

[AG] Arminda Manuela Gonçalves <mneves@math.uminho.pt>

[CM] Carla Moreira <carlamgmm@gmail.com>

[GS] Gueorgui Smirnov <smirnov@math.uminho.pt>

[IS] Inês Sousa <isousa@math.uminho.pt>

[JT] Joana Torres <jtorres@math.uminho.pt>

[JES] José Carlos Espírito Santo <jes@math.uminho.pt>

[JO] José Joaquim Oliveira <jjoliveira@math.uminho.pt>

[PP] Pedro Patrício <pedro@math.uminho.pt>

2.2.2 Professors from UA

[AF] Adelaide Freitas <adelaide@ua.pt>

[AP] Alexander Plakhov <plakhov@ua.pt>

[AFM] Ana Foulquié Moreno <foulquie@ua.pt>

[CC] Conceição Lopes Costa <lopescosta@ua.pt>

[CS] Cristiana Silva <cjoaosilva@ua.pt>

[DH] Dirk Hofmann <dirk@ua.pt>

[EF] Elisa Fernandes <maria.elisa@ua.pt>

[IP] Isabel Pereira <isabel.pereira@ua.pt>

[IB] Ivan Beschastnyi <ibeschastnyi@ua.pt>

[JS] João Manuel da Silva Santos <jmss@ua.pt>

[JX] João Xarez <xarez@ua.pt>

[VS] Vasile Staicu <vasile@ua.pt>

2.2.3 Professors from UP

[AR] Alexandre Rodrigues <alexandre.rodrigues@fc.up.pt>

[FLP] Fernando Lobo Pereira <flp@fe.up.pt>

[MD] Manuel Delgado <mdelgado@fc.up.pt>

[MB] Margarida Brito <mabrito@fc.up.pt>

[SG] Sílvio Gama <smgama@fc.up.pt>

2.3 Students

During the 1st semester we had 14 PhD Students following courses:

[AS] Ana Catarina Lopes Carvalho Sousa <acatarinasousa@ua.pt>

[AB] Angelos Bampounis <angelos.bampounis@ua.pt>

[CA] Carlos Fernando da Silva Arraz <carlos.arraz@ua.pt>

[CF] Catarina Justino Faustino <catarina.0109.cf@gmail.com>

[FG] Franco Anibal Golfieri Madriaga <francogolfieri@ua.pt>

[GC] Gabriel Chicale Cossa <gabriel.cossa@ua.pt>

[HP] Hélder Armando Gonçalves Pinto <helder.pinto@ua.pt>

[JM] João Ricardo Anjos de Sousa Galego Mendonça <jmendonca@ua.pt>

[JC] Jorge Vaz Ramos Rodrigues de Cabral <jorgecabral@ua.pt>

[JD] Juan Enrique Fernández Díaz <juan.enri@ua.pt>

[LB] Laid Boudjellal <laid.boudj@ua.pt> <boudjellallaid1345@gmail.com>

[HC] Maria Hermínia Esteves De Carvalho <mhcarvalho@ua.pt>

[NA] Nilton Osvaldo Benvindo Ávido <benvindo.avido@ua.pt> <capaia1986@gmail.com>

[PM] Paulo Tomás da Silva Tavares Monteiro <ptstm@ua.pt> <ptstm@hotmail.com>

2.4 Fellowships

Nine (9) of the students had a fellowship: 4 from University of Minho; 4 from University of Aveiro; 1 from Angola.

2.4.1 Fellowships via UM

AS Ana Catarina Lopes Carvalho Sousa <acatarinasousa@ua.pt> <ana_96_sousa@hotmail.com>
Fellowship: CMAT-UM
Supervisor: José Carlos Espírito Santo <jes@math.uminho.pt> (UM)

CA Carlos Fernando da Silva Arraz
Fellowship: CMAT-UM
Supervisors: Stéphane Louis Clain (UM) <clain@math.uminho.pt> + Irene Vitória Ribeiro Brito <ireneb@math.uminho.pt> (UM)

CF Catarina Justino Faustino <catarina.0109.cf@gmail.com>
Fellowship: CMAT-UM
Supervisor: Thomas Walter Kahl <kahl@math.uminho.pt> (UM)

LB Laid Boudjellal
Fellowship: CMAT-UM
Supervisors: Ana Jacinta Soares <ajsoares@math.uminho.pt> (UM) + Maria Joana Torres <jtorres@math.uminho.pt> (UM)

2.4.2 Fellowships via UA

FG Franco Anibal Golfieri Madriaga <francogolfieri87@gmail.com> <francogolfieri@ua.pt>
Fellowship: CIDMA-UA
Supervisor: Ariel Martin Pacetti <arielpacetti@gmail.com> (UA)

JM João Ricardo Anjos de Sousa Galego Mendonça <jmendonca@ua.pt>
Título do Plano de Trabalhos: "Categories, graphs and related structures".
Fellowship: CIDMA-UA
Supervisors: Dirk Hofmann <dirk@ua.pt> (UA) + Enide Andrade <enide@ua.pt> (UA)

JC Jorge Vaz Ramos Rodrigues de Cabral <jorgecabral@ua.pt>
Fellowship: CIDMA-UA
Supervisors: Vera Afreixo <vera@ua.pt> (UA) + Pedro Macedo <pmacedo@ua.pt> (UA)

JD Juan Enrique Fernández Díaz <juanen01@ucm.es>
Fellowship: CIDMA-UA
Supervisors: Ana Pilar Foulquié Moreno <foulquie@ua.pt> (UA) + Manuel Mañas Baena <manuel.manas@ucm.es> (Universidad Complutense de Madrid)

2.4.3 Fellowships from Angola

NA Nilton Osvaldo Benvindo Ávido <benvindo.avido@ua.pt> <capaia1986@gmail.com>

2.5 Courses

Fourteen (14) courses were open/running during the 1st Semester:

SEM Seminário (9 ECTS)
Professor: DH
Timetable: Friday, 16h00–18h00
12 Students: FG + AS + JM + AB + CF + LB + CA + JC + JD + HP + PM + NA

2.5.1 Módulos Especializados em Matemática e Aplicações A ($2 \times 6 = 12$ ECTS)

TAALC Tópicos Avançados de Álgebra, Lógica e Computação (6 ECTS)
Professors: PP + EF + MD
Timetable: Thursday 10:00-12:00 + 13:00-15:00
9 Students: FG + AS + JM + CF + GC + JC + HP + JD + NA

TAAO Tópicos Avançados de Análise e Otimização (6 ECTS)
Professors: VS + GS + FLP
Timetable: Wednesday, 14h00–18h00
2 Students: LB + PM

TADG Tópicos Avançados de Dinâmica e Geometria (6 ECTS)
Professors: JT + AR
Responsible at UA: AP
Timetable: Tuesday, 8h30–12h30
6 Students: JM + CF + LB + CA + JD + PM

TAPE Tópicos Avançados de Probabilidade e Estatística (6 ECTS)
Professors: MB + IP + CM
Timetable: Friday, 11h00–13h00 + 14h00–16h00
8 Students: FG + AS + AB + GC + CA + JC + HP+ NA

2.5.2 Módulos Especializados em Matemática e Aplicações B (3 ECTS)

ADL Análise de Dados Longitudinais (3 ECTS)
Professor: IS
Responsible at UA: CC
6 Students: CA + JC + HC + JM + HP+ NA

CV Cálculo das Variações (3 ECTS)
Professor: IB
1 student: FG

ED Equações Diferenciais (3 ECTS)
Professor: JO
Responsible at UA: VS
Timetable: Friday, 9h30 – 11h00
6 Students: LB + JD + AS + CF + AB + PM

2.5.3 Módulos Especializados em Matemática e Aplicações B (6 ECTS)

AMAE Análise Multivariada e Aprendizagem Estatística (6 ECTS)
Professor: AG
Responsible at UA: AF
5 Students: CA + JC + HC + HP+ NA

DMB Dinâmica em Modelos Biológicos (6 ECTS)
Professor: CS
Timetable: Monday, 11h30-13h00 + 14h00-15h30
1 Student: LB

MEN Métodos Espetrais Numéricos (6 ECTS)
Professor: SG

Responsible at UA: JS
1 Student: PM

POA Polinómios Ortogonais e Aplicações (6 ECTS)
Professor: AFM
Timetable: Monday, 9h00-12:00
1 Student: JD

TG Teorias de Galois (6 ECTS)
Professor: JX
Timetable: Tuesday, 15h00 – 18h00, Room: 11.2.25
2 Students: FG + JM

TT Teoria de Tipos (6 ECTS)
Professor: JES
Timetable: Tuesday, 14h30–17h30
Responsible at UA: DH
2 Students: AS + CF

2.6 Seminars

The MAP-PDMA PhD Program 2021/2022 organized 16 seminars, that took place at Room 11.3.21 of DMat-UA.

2.6.1 Seminar #16: January 31, 15h00

- Place: via Zoom, URL: `https://videoconf-colibri.zoom.us/j/86389857315`
- Title: Modeling and forecasting with stochastic differential equations and other stochastic processes
- Speaker: Paula Milheiro Oliveira, Faculdade de Engenharia da Universidade do Porto, poliv@fe.up.pt
- Abstract: Many real world systems exhibit a stochastic behavior as a result of random influences or uncertainty. Examples of these type of stochastic dynamics occur throughout the physical, social and life sciences as well as in engineering, just to name a few domains.

  Various methods of advanced modelling are needed for an increasing number of complex systems. For a model to describe the future evolution of the system, it must: (i) capture the inherently linear or non-linear behavior of the system; (ii) provide means to accommodate for noise due to approximations and measurement errors. This calls for methods that are capable of bridging the gap between physical world and statistical modelling.

  We will give an overview on the modeling procedure and illustrate the main ideas on a couple of real world examples. Many other examples exist including in other fields of application, e.g. in population growth, the neurosciences, infectious diseases and epidemiology, the new green energy systems, financial markets, new materials and mechanical structures. Once the mode is fit, forecasting equations can be derived by applying statistical principles. Short term as well as long term forecasts can be computed.

  We will depart from the fundamental concepts on stochastic differential equations and present the main up to date challenges in terms of modeling and forecasting. The need for using Stochastic Differential Equations also appears in a rather natural way in problems involving Big Data. We will make this relation evident in the exposition. Computer programs and languages like R or Matlab are useful in solving this type of modeling problems.

- References

  [1] Braumann, C.A. (2019). Introduction to Stochastic Differential Equations with Applications to Modeling in Biology and Finance. Wiley.

  [2] Mao, X. (2007). Stochastic differential equations and their applications. Horwood Publishing.

2.6.2 Seminar #15: January 28, 17h15

- Place: via Zoom, URL: `https://videoconf-colibri.zoom.us/j/86389857315`
- Title: Determining groups in multiple survival curves
- Speaker: Luís Meira-Machado, Centre of Mathematics, University of Minho
- Abstract: Survival analysis includes a wide variety of methods for analyzing time-to-event data. One basic but important goal in survival analysis is the comparison of survival curves between groups. Several nonparametric methods have been proposed in the literature to test for the equality of survival curves for censored data. When the null hypothesis of equality of curves is rejected, leading to the clear conclusion that at least one curve is different, it can be interesting to ascertain whether curves can be grouped or if all these curves are different from each other. A method is proposed that allows determining groups with an automatic selection of their number. The applicability of the proposed method is illustrated using real data. We will discuss the possibility of extending the proposed methods to determine groups is other curves such as the cumulative hazard curves in competing risks model.
- References

  [1] N.M. Villanueva, M. Sestelo, L. Meira-Machado, A method for determining groups in multiple survival curves, Statistics in Medicine, 38(5), 866–877, 2019.

  [2] L. Meira-Machado, M. Sestelo, Estimation in the progressive illness-death model: A nonexhaustive review, Biometrical Journal 61(2), 245–263, 2019.

  [3] N.M. Villanueva, M. Sestelo, L. Meira-Machado, J. Roca-Pardiñas, clustcurv: An R Package for Determining Groups in Multiple Curves, The R Journal, 13, 2073–4859, 2021.

2.6.3 Seminar #14: January 28, 16h15

- Place: via Zoom, URL: `https://videoconf-colibri.zoom.us/j/86389857315`
- Title: Polarized natural deduction
- Speaker: José Espírito Santo, Center of Mathematics, University of Minho
- Abstract: A natural deduction system [1] is presented for polarized, intuitionistic, propositional logic with several interesting properties [2]: it has a privileged relationship with a standard focused sequent calculus [3]; it enjoys the subformula property; polarity decides whether the elimination rules are generalized or not [4]; there are no commutative conversions; and even atomic formulas have introduction, elimination and normalization rules. In the corresponding polarized lambda-calculus, reduction follows a paradigm that subsumes both call-by-name and call-by-value [5].
- References

  [1] Dag Prawitz. Natural Deduction. A Proof-Theoretical Study. Almquist and Wiksell, Stockholm, 1965.

  [2] José Espírito Santo. The polarized λ-calculus. Electronic Notes in Theoretical Computer Science 332: 149–168, 2017.

[3] Chuck Liang and Dale Miller. Focusing and polarization in linear, intuitionistic, and classical logics. Theoretical Computer Science, 410(46):4747–4768, 2009.

[4] Jan von Plato. Natural deduction with general elimination rules. Archive for Mathematical Logic, 40(7):541–567, 2001.

[5] Paul B. Levy. Call-by-push-value: Decomposing call-by-value and call-by-name. Higher Order and Symbolic Computation, 19(4): 377–414, 2006.

2.6.4 Seminar #13: January 21, 2022, 17h00

- Title: Dynamic neural fields: theory and applications
- Speaker: Wolfram Erlhagen, Centre of Mathematics, University of Minho
- Abstract: Dynamic Neural Fields (DNFs) formalized by nonlinear integro-differential equations have been originally introduced as a model framework for explaining basic principles of neural information processing in which the interactions of billions of neurons are treated as a continuum. The intention is to reduce the enormous complexity of neural interactions to simpler population properties that are tractable by mathematical analysis. More recently, complex models consisting of several connected DNFs have been developed to explain higher level cognitive functions (e.g., memory, decision making, prediction and learning) and to implement these functionalities in autonomous robots. I will give an overview about the physiological motivation of DNFs, the mathematical analysis of their dynamic behaviors, and their application in cognitive robotics. As an example study, I focus on "multi-bump" solutions that have been proposed as a neural substrate for a multi-item memory function. I show how the existence and stability properties of these solutions can be exploited to endow a robot with the capacity to efficiently learn the timing and serial order of sequential events. I also discuss new mathematical challenges that are motivated by robotics applications.
- References

[1] S.-I. Amari (1977). Dynamics of pattern formation in lateral-inhibition type neural fields, Biological Cybernetics 27 (2), 77-87.

[2] W. Erlhagen, E. Bicho (2006). The dynamic neural field approach to cognitive robotics, Journal of Neural Engineering 3 (3), R36

[3] F. Ferreira., W. Erlhagen, E. Bicho (2016). Multi-bump solutions in a neural field model with external inputs. Physica D: Nonlinear Phenomena, 326, 32-51.

[4] W. Wojtak, S. Coombes, D. Avitabile, E. Bicho, W. Erlhagen (2021). A dynamic neural field model of continuous input integration. Biological Cybernetics, 1-21.

[5] F. Ferreira, W. Wojtak, E. Sousa, L. Louro, E. Bicho, W. Erlhagen (2020). Rapid learning of complex sequences with time constraints: A dynamic neural field model. IEEE Transactions on Cognitive and Developmental Systems. DOI: 10.1109/TCDS.2020.2991789

2.6.5 Seminar #12: January 21, 2022, 16h00

- Title: Expected utility theory and clustering
- Speaker: Irene Brito, Center of Mathematics, University of Minho
- Abstract: In decision theory, for example in the actuarial and economic context, the expected utility model describes how individuals choose between uncertain or risky prospects [1]. According to that model, there exists a utility function to appraise different risky outcomes and a decision maker chooses the outcome which maximizes expected utility. The utility function is used to model the individual's preferences.

  Several problems in machine learning, for example data classification problems, rely on partitioning a given data set into disjoint, non-empty subsets. Clustering is a process of

organizing a data set into subsets – clusters – in such a way that objects belonging to the same cluster are similar [2]. The aim is to form a partition, where the clusters are constructed using a metric (for example the Euclidean metric), minimizing the dissimilarity between elements belonging to the same cluster.

The aim of utility clustering is to solve classification problems taking into account the preferences of decisions, by replacing the usual metrics with utility functions [3].

In this seminar I will present a brief introduction to the theory of expected utility and to clustering and explain then the fundamentals of the utility clustering theory. The equivalence of the traditional K-means clustering and the utility clustering with a quadratic utility function will be shown [3].

- References

[1] R. Kaas et al., Modern actuarial risk theory, 2nd ed., Springer, 2008.

[2] B.S. Everitt et al., Cluster Analysis, 5th Edition, Wiley and Sons, 2011.

[3] S. Clain, I. Brito, Utility clustering, in preparation, 2021.

2.6.6 Seminar #11: January 14, 17h15

- Title: Study of convex Semi-infinite Programming problems: general approaches, applications, and open problems
- Speaker: Tatiana Tchemisova, CIDMA, Department of Mathematics, University of Aveiro
- Abstract: Problems of convex Optimization consist in search for extrema of convex functions in domains which are convex sets. Many times the success of the process of solution of such problems depends on the way how the feasible sets are described. The problems where the feasible sets are described with the help of a finite number of convex functions (constraint functions) belong to the convex Nonlinear Programming; such problems are rather well studied and there are solvers developed for them. In the case when the number of constraints is infinite, we deal with problems of Semi-infinite Programming.

  In the talk, we present different approaches to solving convex SIP problems, and speak about the open questions and problems.

2.6.7 Seminar #10: January 14, 16h15

- Title: Compositional data: some challenges in the world of multivariate statistics
- Speaker: Adelaide Freitas, CIDMA, Department of Mathematics, University of Aveiro
- Abstract: In the relative scale, 5% is a half of 10% and 45% forms a fraction of 0.9 of 50%. Obviously! However, in absolute scale, both comparisons produce the same difference. Whenever multivariate observations in a data set represent quantitative descriptions of the parts of some whole, conveying only relative information between parts, statistical techniques adequate to analyze compositional data should be used. Since compositional data are positive multivariate data with constant sum constraint, classic statistical methods (dealing with differences) can be not appropriate to be considered on them. Compositional data has emerged over the last years in numerous scientific fields. We illustrate some examples and list some difficulties to work with compositional data, namely in the area of exploratory multivariate statistics. We review some transformations proposed to overcumber the constraint imposed by the definition and discuss some challenges in the analysis of compositions of compositional data.

2.6.8 Seminar #9: December 17, 16h30

- Place: via zoom, `https://videoconf-colibri.zoom.us/j/86389857315`
- Title: Multivariate and multiscale complexity under long-range correlation: application in cardiovascular variability
- Speaker: Ana Paula Rocha, CMUP, Department of Mathematics, University of Porto
- Abstract: An intrinsic feature of some physiological or econometric systems, is their dynamical complexity, resulting from the activity of several coupled mechanisms operating across multiple temporal scales. The cardiovascular system is one of such systems and specific complex characteristics such as long memory and volatility have been considered from a model based ARFIMA-GARCH parametric viewpoint. Entropy rate is another current measure of complexity. Recently, an efficient estimation of the linear multiscale entropy (MSE) was introduced using a state space formulation, able to attend the simultaneous presence of short-term dynamics and long-range correlations by using ARFI modeling. Given the interactions present in these systems, natural generalizations consider a multivariate approach with VARFI models. Within this framework, for Gaussian processes, we propose to estimate the Transfer Entropy, or equivalently Granger Causality, allowing to quantify the information flow and assess directed interactions accounting for long-range correlations.

  The methods are applied in experimental and clinical cardiovascular stress situations, allowing to discriminate between health and disease and to assess disease severity. Moreover the developed measures appear to reflect the changes in the cardiovascular variability system dynamics.

2.6.9 Seminar #8: December 10, 16h30

- Place: via zoom, `https://videoconf-colibri.zoom.us/j/86389857315`
- Title: From Newton's cooling law to turbulent filtration of non-Newtonian fluids through a porous medium
- Speaker: Eurica Henriques, Dep. of Mathematics – University of Trás-os-Montes e Alto Douro (UTAD), Centre of Mathematics CMAT – University of Minho: Pole CMAT-UTAD
- Abstract: Differential equations govern several phenomena and their study gives rise to some answers and several other questions. In this seminar we go on a tour starting at Newton's cooling law (an ordinary differential equation), stoping briefly at some well known partial differential equations (pde) and ending on a doubly nonlinear pde. We will present recent results concerning regularity aspects of the weak solutions to the doubly nonlinear PDE

$$u_t - \operatorname{div}\big(|u|^{m-1}|Du|^{p-2}Du\big) = 0, \qquad p > 1.$$

2.6.10 Seminar #7: December 3, 16h30

- Place: via zoom, `https://videoconf-colibri.zoom.us/j/86389857315`
- Title: Pak-Stanley labeling of hyperplane arrangements
- Speaker: Rui Duarte, CIDMA, Department of Mathematics, University of Aveiro
- Abstract: In the nineties Pak and Stanley introduced a construction in which every region of the m-Shi arrangement of hyperplanes is labeled with a m-parking function. In this talk we consider the same construction applied to the regions of the m-Catalan arrangement and to the regions of the Ish arrangement. We characterize the Pak-Stanley labels of the regions and of the relatively bounded regions of these arrangements. Finally, we present an algorithm for the inverse.

  This is joint work with António Guedes de Oliveira (CMUP, Department of Mathematics, University of Porto)

2.6.11 Seminar #6: November 26, 16h15

- Place: via zoom, `https://videoconf-colibri.zoom.us/j/86389857315`
- Speaker: Thomas Kahl, Center of Mathematics, University of Minho
- Title: Algebraic topology and concurrency theory
- Abstract: It has been discovered relatively recently that concepts and methods from algebraic topology may be employed profitably in concurrency theory, the field of computer science that studies systems of simultaneously executing processes. A very expressive combinatorial-topological model of concurrency is given by higher-dimensional automata. In this talk, I will present a method to extract homological information from HDAs that is meaningful from a computer science point of view.

2.6.12 Seminar #5: November 26, 16h15

- Speaker: Vera Afreixo, CIDMA, University of Aveiro
- Title: Stable variable selection — an approach based on penalized regression procedures
- Abstract: The challenge in finding a plausible method to apply in genomic data is due to its high dimensionality. Penalized regression methods were applied in a combined way with methods based on Akaike's Information Criterion (AIC) to evaluate the importance of potential predictors and to contribute to stable variable selection.

2.6.13 Seminar #4: November 12, 16h30

- Place: via zoom, `https://videoconf-colibri.zoom.us/j/86389857315`
- Speaker: Ana Jacinta Soares, Centre of Mathematics, University of Minho
- Title: Modeling and applications in kinetic theory of mixtures
- Abstract: In many problems arising in the interface of mathematics with engineering, natural and life sciences, one important aspect is the presence of different scaling regimes of evolution. For example, when modeling biological systems, one should describe not only the global behaviour of the cellular populations but also the cellular dynamics and the biological expression of cells. In fluid dynamics, many problems are described by a macroscopic approach, like Euler or Navier-Stokes, but a microscopic model is needed to describe transition regimes like gas-surface interactions. The kinetic theory is a branch of statistical mechanics that provides a detailed description of the gas at small scales. It allows to obtain the corresponding macroscopic analogue as the hydrodynamic limit of the kinetic equations. Thus, it offers a very convenient approach to many different problems.

  In this seminar, I will present some interesting problems and applications of the kinetic theory to both fluid dynamical processes and and biological systems.

2.6.14 Seminar #3: November 5, 16h15

- Speaker: Domenico Catalano, CIDMA, University of Aveiro
- Title: Hypermaps and their classification
- Abstract: Maps are embeddings of graphs on compact surfaces generalized by hypermaps, replacing graphs by hypergraphs. There are three main approaches to investigate and partially classify hypermaps. Namely by studying hypermaps • on the same surface or class of surfaces, • with the same hypergraph or class of hypergraphs, • with the same group or class of groups of symmetries. After an introduction to the topic, I will give an idea how classifications of hypermaps can be achieved in each of the above three main ways.

2.6.15 Seminar #2: October 29, 16h00

- Speaker: Dirk Hofmann, CIDMA, University of Aveiro
- Title: It's all about the maps
- Abstract: Category theory is a relatively new area of mathematics which arose originally from the study of a relationship between geometry and algebra; by now it pervades almost all of modern mathematics. Intuitively, every discipline of mathematics can be organised in at least one category; furthermore, category theory encourages a shift of perspective: the focus is placed on the relations (maps or morphisms) between entities (spaces, groups, rings, ...) rather than emphasising the entities themselves. In this talk we give an introduction into the theory of categories and the vocabulary surrounding it. We pay special attention to what is is arguably the most successful categorical notion: that of an adjunction. If time permits, we will go one step further and follow Bill Lawvere's important observation that "... the kinds of structures which actually arise in the practice of geometry and analysis are far from being 'arbitrary' ..., as concentrated in the thesis that fundamental structures are themselves categories."

2.6.16 Seminar #1: October 22, 16h00

- Speaker: Ivan Beschastnyi, CIDMA, University of Aveiro
- Title: Sub-Riemannian geometry and its applications
- Abstract: In this talk I will explain the basic notions of sub-Riemannian geometry. It is a geometry that models dynamical systems with constraints. Even though its formal definition arose fairly recently, in the end of the XX century, its roots go to antiquity and the isoperimetric problem. After the main definitions are be given, I will show some applications to robotics and neuroscience.

3 2nd Semester

The 2nd semester began March 7th, 2022.

3.1 Professors involved

Thirty seven (37) Professors were involved during the 2nd Semester: 10 from University of Minho (UM); 13 from University of Aveiro (UA); and 14 from University of Porto (UP).

3.1.1 Professors from UM

- Ana Jacinta Soares <ajsoares@math.uminho.pt>
- Irene Brito <ireneb@math.uminho.pt>
- Joana Torres <jtorres@math.uminho.pt>
- José Carlos Espírito Santo <jes@math.uminho.pt>
- Lucile Vandembroucq <lucile@math.uminho.pt>
- Maria Irene Falcão <mif@math.uminho.pt>
- Pedro Patrício <pedro@math.uminho.pt>
- Stéphane Louis Clain <clain@math.uminho.pt>
- Susana Faria <sfaria@math.uminho.pt>
- Thomas Walter Kahl <kahl@math.uminho.pt>

3.1.2 Professors from UA

- Ana Foulquié Moreno <foulquie@ua.pt>
- Ariel Martin Pacetti <apacetti@ua.pt>
- Delfim F. M. Torres <delfim@ua.pt>
- Dirk Hofmann <dirk@ua.pt>
- Isabel Pereira <isabel.pereira@ua.pt>
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- Rui Duarte <rduarte@ua.pt>
- Tatiana Tchemisova <tatiana@ua.pt>
- Vera Afreixo <vera@ua.pt>

3.1.3 Professors from UP

- Alberto Pinto <aapinto@fc.up.pt>
- Ana Paula Rocha <aprocha@fc.up.pt>
- Ana Rita Gaio <argaio@fc.up.pt>
- Fernando Fontes <faf@fe.up.pt>
- Fernando Lobo Pereira <flp@fe.up.pt>
- Helena Reis <hreis@fep.up.pt>
- João Gama <jgama@fep.up.pt>
- José Abílio Oliveira Matos <jamatos@fep.up.pt>
- Leatitia Teixeira <lcteixeira@icbas.up.pt>
- Manuela Aguiar <maguiar@fep.up.pt>
- Maria Margarida Cardoso <mcard@icbas.up.pt>
- Maria Paula Brito <mpbrito@fep.up.pt>
- Óscar Felgueiras <olfelgue@fc.up.pt>
- Paula Milheiro de Oliveira <poliv@fe.up.pt>

3.2 Students

During the 2nd semester we had 16 PhD Students following courses:

[AS] Ana Catarina Lopes Carvalho Sousa <acatarinasousa@ua.pt>

[AB] Angelos Bampounis <angelos.bampounis@ua.pt>

[CA] Carlos Fernando da Silva Arraz <carlos.arraz@ua.pt>

[CF] Catarina Justino Faustino <catarina.0109.cf@gmail.com>

[FG] Franco Anibal Golfieri Madriaga <francogolfieri@ua.pt>

[GC] Gabriel Chicale Cossa <gabriel.cossa@ua.pt>

[HP] Hélder Armando Gonçalves Pinto <helder.pinto@ua.pt>

[JF] João Freitas <joao.costafreitas@outlook.pt>

[JM] João Ricardo Anjos de Sousa Galego Mendonça <jmendonca@ua.pt>

[JG] Joaquim Gomes <joa.gome@ua.pt>

[JC] Jorge Vaz Ramos Rodrigues de Cabral <jorgecabral@ua.p>

[JD] Juan Enrique Fernández Díaz <juan.enri@ua.pt>

[LB] Laid Boudjellal <laid.boudj@ua.pt> <boudjellallaid1345@gmail.com>

[HC] Maria Hermínia Esteves De Carvalho <mhcarvalho@ua.pt>

[NA] Nilton Osvaldo Benvindo Ávido <benvindo.avido@ua.pt> <capaia1986@gmail.com>

[PM] Paulo Tomás Da Silva Tavares Monteiro <ptstm@ua.pt> <ptstm@hotmail.com>

3.3 Courses

Fourteen (14) courses were open/running during the 2nd Semester:

1. Alterações Climáticas e Energia (6 ECTS), Alberto Pinto (UP)
   Responsible Professor at UA: Natália Martins
   Students: HC + JF

2. Bioestatística, (6 ECTS) – Ana Rita Gaio, Leatitia Teixeira, Margarida Cardoso (UP)
   Responsible Professor at UA: Vera Afreixo
   Students: HP

3. Equações Diferenciais com Simetria (6 ECTS) – Manuela Aguiar (UP)
   Responsible Professor at UA: Delfim Torres
   Students: FG + JD

4. Estatística Bayesiana (3 ECTS), Isabel Pereira (UA)
   Students: HP + JG + NA

5. Estatística Genómica (6 ECTS), Vera Afreixo (UA)
   Students: CA + JC+ JG

6. Geometria Combinatória (3 ECTS), Rui Duarte (UA)
   Students: CF + FG + JM

7. Modelos Lineares Generalizados (3 ECTS), Susana Faria (UM), Ana Rita Gaio (UP)
   Responsible Professor at UA: Marco Costa
   Students: JC

8. Otimização, Controlo e Estimação Dinâmicas (6 ECTS), Lobo Pereira, Fernando Fontes (UP)
   Responsible Professor at UA: Lígia Abrunheiro
   Students: LB

9. Sistemas Estocásticos e Aplicações (6 ECTS), Paula Milheiro, José Abílio Matos (UP)
   Responsible Professor at UA: Tatiana Tchemisova
   Students: NA

10. Teoria Algébrica das Inversas generalizadas (3 ECTS), Pedro Patrício (UM)
    Responsible Professor at UA: Rui Duarte
    Students: CA + CF + JD + JM

11. Teoria de Singularidades (6 ECTS), Manuela Aguiar + Isabel Labouriau (UP)
    Students: FG

12. Tópicos de Análise Numérica (3 ECTS), Maria Irene Falcão (UM)
    Responsible Professor at UA: Manuela Rodrigues
    Students: AS + LB

13. Topologia Algébrica (3 ECTS), Lucile Vandembroucq (UM), Helena Reis (UP)
    Responsible Professor at UA: Rui Duarte
    Students: CF + JM

14. Projecto de Investigação em Matemática (PIM): see Section 3.4.

3.4 PIM

The Responsible Professor for PIM was Dirk Hofmann, UA `<dirk@ua.pt>`.

We had 13 students in PIM and all of them ended their PIM with success.

1. Student: AS
   Professor: José Carlos Espírito Santo, UM <jes@math.uminho.pt>

2. Student: CA
   Professor 1: Irene Brito, UM <ireneb@math.uminho.pt>
   Professor 2: Stéphane Louis Clain, UM <clain@math.uminho.pt>

3. Student: CF
   Professor: Thomas Walter Kahl, UM <kahl@math.uminho.pt>

4. Student: FG
   Professor: Ariel Martin Pacetti, UA <apacetti@ua.pt>

5. Student: HC
   Professor: Maria Paula Brito, UP <mpbrito@fep.up.pt>

6. Student: HP
   Professor: Ana Paula Rocha, UP <aprocha@fc.up.pt>

7. Student: JC
   Professor 1: Vera Mónica Almeida Afreixo, UA <vera@ua.pt>
   Professor 2: Pedro Filipe Pessoa Macedo, UA <pmacedo@ua.pt>

8. Student: JD
   Professor: Ana Foulquié Moreno, UA <foulquie@ua.pt>

9. Student: JF
   Professor 1: Alberto Adrego Pinto <aapinto@fc.up.pt>
   Professor 2: Óscar Felgueiras <olfelgue@fc.up.pt>
   Professor 3: João Gama <jgama@fep.up.pt>

10. Student: JM
    Professor: Dirk Hofmann, UA <dirk@ua.pt>

11. Student: LB
    Professor 1: Ana Jacinta Soares, UM <ajsoares@math.uminho.pt>
    Professor 2: Joana Torres, UM <jtorres@math.uminho.pt>

12. Student: NA
    Professor 1: Paula Milheiro de Oliveira, UP <poliv@fe.up.pt>
    Professor 2: José Abílio Oliveira Matos, UP <jamatos@fep.up.pt>

13. Student: PM
    Professor: Tatiana Tchemisova <tatiana@ua.pt>

4 Concluded PhD theses during 2022

1. Faïçal Ndaïrou
   Fractional Optimal Control and Biological Applications
   `https://ria.ua.pt/handle/10773/35978`
   Supervisors: Delfim Torres (UA) and Ivan Area (Univ. Vigo, Galicia)
   Fellowship: PD/BD/150273/2019
   2022, December

2. Simon Ranjith Jeyabalan
   Dynamics of Large-Scale Perturbations of Steady Convective Dynamos in a Horizontal Plane Layer of Electrically Conducting Fluid
   `https://hdl.handle.net/10216/146678`
   Supervisors: Roman Chertovskikh (UP), Sílvio Gama (UP) and Vladislav Zheligovsky (Russian Academy of Sciences, Moscow)
   Fellowship: PD/BD/142889/2018
   2022, November

3. Zine Houssine
   Stochastic Fractional Generalizations in Optimal Control
   `https://ria.ua.pt/handle/10773/34382`
   Supervisor: Delfim Torres (UA)
   2022, July

4. Atefeh Afsar
   Applications of Game Theory and Dynamical Systems to Biology and Economy
   `https://repositorio-aberto.up.pt/handle/10216/141729`
   Supervisors: Alberto Pinto (UP) and Bruno Oliveira (UP)
   Fellowship: PD/BD/142886/2018
   2022, July

5. Gustavo Domingos da Costa Coelho Soutinho
   Statistical Analysis of Complex Survival Data: New Contributions in Statistical Inference, Software Development and Biomedical Applications

https://repositorio-aberto.up.pt/handle/10216/141584
Supervisors: Pedro Oliveira (UP) and Luis Machado (UM)
Fellowship: SFRH/PD/BD/142887/2018
2022, June

6. Rômulo Teixeira Rodrigues
Perception-Aware Motion Planning for Autonomous Robotic Vehicles
https://repositorio-aberto.up.pt/handle/10216/141106
Supervisors: António Pedro Aguiar (UP) and António Pascoal (IST)
Fellowship: NORTE-08-5369-FSE-000061, P2020|Norte2020 – PDMA
2022, May

7. Claudio Alexandre Guerra Silva Gomes da Piedade
Faithful Permutation Representations of C-groups
https://ria.ua.pt/handle/10773/33912
Supervisor: Maria Elisa Fernandes (UA)
Fellowship: PD/BD/142888/2018
2022, April

5 Publications of 2022

1. Cruz, F. , Almeida, R. & Martins, N. (2022). Herglotz variational problems involving distributed-order fractional derivatives with arbitrary smooth kernels. Fractal Fract. 6(12), 731, 18 pp.
https://doi.org/10.3390/fractalfract6120731

2. Zine, H., Danane, J., & Torres, D. F. M. (2022) A stochastic capital-labour model with logistic growth function. In: Dynamic Control and Optimization, Springer Nature Switzerland AG, 231–241.
https://doi.org/10.1007/978-3-031-17558-9_13

3. Marques, G., Gama, S., & Pereira, F. L. (2022). Optimal Control of a Passive Particle Advected by a Lamb–Oseen (Viscous) Vortex. Computation, 10(6), 87.

4. Jeyabalan, S. R., Chertovskih, R., Gama, S., & Zheligovsky, V. (2022). Nonlinear Large-Scale Perturbations of Steady Thermal Convective Dynamo Regimes in a Plane Layer of Electrically Conducting Fluid Rotating about the Vertical Axis. Mathematics, 10(16), 2957.

5. Zine, H, Lotfi, EM, Torres, DFM & Yousfi, N (2022) Weighted generalized fractional integration by parts and the Euler-Lagrange equation. Axioms 11 , no. 4, Art. 178, 10 pp.
http://doi.org/10.3390/axioms11040178

6. Zine, H, Lotfi, EM, Torres, DFM & Yousfi, N (2022) Taylor's formula for generalized weighted fractional derivatives with nonsingular kernels. Axioms 11, no. 5, Art. 231, 10 pp.
http://doi.org/10.3390/axioms11050231

7. Zine, H, El Adraoui, A & Torres, DFM (2022) Mathematical analysis, forecasting and optimal control of HIV/AIDS spatiotemporal transmission with a reaction diffusion SICA model. AIMS Mathematics 7, no. 9, 16519–16535.
http://doi.org/10.3934/math.2022904

8. Zine, H, Danane, J & Torres, DFM (2022) Stochastic SICA epidemic model with jump Lévy processes. In: Mathematical Analysis of Infectious Diseases, Academic Press, 61–72.
http://doi.org/10.1016/B978-0-32-390504-6.00009-7

9. Boukhouima, A, Zine, H, Lotfi, EM, Mahrouf, M, Torres, DFM & Yousfi, N (2022) Lyapunov functions and stability analysis of fractional-order systems. In: Mathematical Analysis of Infectious Diseases, Academic Press, 125–136.
http://doi.org/10.1016/B978-0-32-390504-6.00013-9

10. Martinelli, E. (2022) Injective Hulls of Quantale-Enriched Multicategories. Applied Categorical Structures, 30(1), pp. 33–78.
https://doi.org/10.1007/s10485-021-09650-0