CMAT
Centre of Mathematics

Book of Abstracts

of the ALC Meeting 2023

CMAT, University of Minho, Portugal

Contents

About the ALC Meeting

The ALC Meeting is organised by the research group Algebra, Logic and Computation (ALC) of the Centre of Mathematics (CMAT) at the University of Minho.

The purpose of the meeting is to bring together all the members of the ALC group, as well as their master and doctoral students, providing an opportunity to present new results and to discuss the latest research and developments in the scientific areas of interest to the group. It is intended to strengthen collaborations and to establish new connections within the group.

The 2023 Edition of the ALC Meeting

The ALC meeting 2023 takes place Monday, 18 December 2023 at the laboratory Lab4, Department of Mathematics, Gualtar Campus, University of Minho. The meeting is planned as an on site event; the talks will be shared via Zoom with participants from outside of Braga.

Organising Committee

The organising committee of the 2023 edition of the ALC meeting consists of the ALC members Carla Ferreira, René Gazzari and Luís Pinto.

Funding

The ALC Meeting 2023 has the support of the national funds through the Portuguese science foundation FCT - Fundação para a Ciência e a Tecnologia, I.P., under the scope of the projects UIDB/00013/2020 and UIDP/00013/2020 (CMAT-Univ Minho).

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Schedule

09:20 - **09:30** *Welcome and Opening*

09:30 - **10:30** Invited Talk · Rui Barbosa, *Partial algebraic structures and the logic of quantum computation*

10:30 - **11:00** Rui Ralha, *The Perron vector* versus *Pareto efficient vectors in AHP*

11:00 - **11:30** · *Coffee Break* ·

11:30 - **11:50** André Mendes, *Machine learning applied to the quantum circuit layout problem*

11:50 - **12:10** Ana Lopes, *Computer-assisted proofs for matrix identities through Gröbner bases*

12:10 - **12:30** Hugo Martins, *Partial classical propositional logic*

12:30 - **13:00** Outreach Talk · Edite Felgueiras, Fábio Faria, Ana Carvalho and Maria Antónia Forjaz, *Lights, Camera, . . . Science! Promoting science through a film festival*

13:00 - **14:45** · *Lunch Break* ·

14:45 - **15:15** Faustino Maciala, *Drazin inverse of some graph matrices*

15:15 - **15:45** Filipa Mendes, *The logical essence of compiling with continuations*

16:45 - **16:15** Viviani Spreafico and Paula Catarino, *On a model of generalized $(k; p; s)$-Padovan-Perrin sequences*

16:15 - **16:45** · *Coffee Break* ·

16:45 - **17:15** José Carlos Costa, *Asymptotic behavior of the overlap gap between left-infinite and right-infinite words*

17:15 - **17:45** Pedro Patrício, *A note on tensor equations*

17:45 *Closing*

List of Abstracts

1 Rui Barbosa. Partial algebraic structures and the logic of quantum computation

Partial boolean algebras (pBAs) were introduced by Kochen and Specker in their seminal work on contextuality, a key non-classical signature of quantum mechanics, which has more recently been linked to quantum computational advantage. They provide a natural (algebraic-)logical setting for contextual systems, corresponding to a calculus of partial propositional functions. In contrast to traditional quantum logic à la Birkhoff–von Neumann, based on orthomodular lattices, operations such as conjunction and disjunction are partial, only defined in the domain where they are physically meaningful. In the key example of the projectors on a Hilbert space, the operations are only defined for commuting projectors, which correspond to properties of the quantum system that can be tested simultaneously. Contextuality manifests in that forcing totality leads to a contradiction, by collapsing to the trivial one-element Boolean algebra where $0 = 1$. A large part of the foundations of quantum theory can be developed in terms of pBAs, but a subtle issue arises when representing the Hilbert space tensor product, crucial for a compositional account of quantum information-processing.

In this talk I will give an overview of some recent work revisiting this topic, in collaboration with Samson Abramsky, including the results presented at CSL 2021 and QPL 2023 and more recent work in progress and open questions.

2 Rui Ralha. The Perron vector versus Pareto efficient vectors in AHP

The Analytic Hierarchy Process (AHP), proposed by T. L. Saaty in 1980, is a multiple criteria decision-making tool that has been used in many areas including strategic planning (public and private), project/product/vendor management, market research, finance and banking. To help in the decision, AHP associates a weight to each one of the set of alternatives. Such weights are computed from pairwise comparison matrices whose entries are positive and satisfy $a(i,j) = 1/a(j,i)$. Comparisons made by the decisors do not produce, in general, consistent matrices, i.e., the condition $a(i,j) \times a(j,k) = a(i,k)$ will not, in general, be satisfied for every (i,j,k). In AHP, the Perron eigenvector is taken as the vector of weights and the corresponding eigenvalue used to measure the ratio of inconsistency of the matrix. Small ratios are acceptable. Other authors have claimed that the Perron eigenvector should be replaced by a so-called "efficient" vector. We present a numerical example that supports our claim that the Perron eigenvector is indeed the better choice.

3 André Mendes. Machine learning applied to the quantum circuit layout problem

Just as classical computer programs need to be compiled to a target computer architecture, quantum circuits need to be compiled to a target quantum computer. This process poses various challenges to overcome, the biggest of those the mapping/routing of logical qubits to the physical qubits of the quantum computer. In this talk, we address this problem and possible solutions, presenting examples and future challenges.

4 Ana Lopes. Computer-assisted proofs for matrix identities through Gröbner bases

We will illustrate how Gröbner bases can be applied to obtain proofs of some results about matrix identities. More specifically, we will address some properties concerning generalized inverses of matrices. To this end we make use of the OperatorGB package for SageMath, which provides a computational framework for constructing proofs through Gröbner bases.

5 Hugo Martins. Partial classical propositional logic

We will present a type of quantum logic, named partial classical propositional logic, studied by Kochen and Specker. We will define partial algebras and partial Boolean algebras, illustrating with some examples. We will also explore the concept of validity originated by partial Boolean algebras, comparing the notions of validity in this logic and in classical propositional logic. A logical calculus, which axiomatizes validity in partial classical propositional logic, will also be examined.

6 Edite Felgueiras[a], Fábio Faria[b], Ana Carvalho[c] and Maria Antónia Forjaz. Lights, Camera, . . . Science! Promoting science through a film festival

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Films are powerful communication tools.
One of the biggest challenges in science is the communication of complex concepts to non-specialized audiences. Through films, science can disseminate information and, at the same time, engage viewers emotionally with the content [1].
In recent decades, there has been a proliferation of science films [2], and, as a result of this boom, science film festivals have also emerged.

In this talk, we will cover the behind-the-scenes lessons learned from the setting up of a new science film festival – Braga Science Film Fest –, as well as how we brought together nearly 700 online viewers from 25 countries to watch science-related films.

References

[1] Pasquali, M. (2007). Video in science: Protocol videos: The implications for research and society. *EMBO reports*, 8(8), 712-716.

[2] Gouyon, J. B. (2016). Science and film-making. *Public Understanding of Science*, 25(1), 17-30.

7 Faustino Maciala. Drazin inverse of some graph matrices

In the paper titled "Group Inverses of Matrices Associated with Certain Graph Classes" (J.J. McDonald, R. Nandi, K.C. Sivakumar, Electronic Journal of Linear Algebra, 2022, vol. 38), the authors addressed the group inverse of some graph matrices. In this talk, we will generalize their results, focussing on two graph classes: the double star digraph and digraph linked stars (gls). The elucidation of the mathematical framework employed in this generalization will be a key focus of our discussion.

8 Filipa Mendes. The logical essence of compiling with continuations

Plotkin's call-by-value (CBV) λ-calculus is incomplete for the continuation-passing-style (CPS) semantics. Moggi's computational λ-calculus is an alternative CBV language solving the incompleteness problem. There is a reflection of the CPS target back to Moggi's language, meaning that doing the CPS translation is equivalent to a source language transformation converting to "administrative" normal form. This fact was dubbed the "essence of compiling with continuations". This story has a typed/logical version which includes a hidden protagonist, a certain sequent calculus called LJQ. There is an alternative, equivalent translation of Moggi's language into the proof system LJQ, after the latter is conveniently turned into a CBV λ-calculus. The alternative translation does not need to introduce double negations, thanks to the expressiveness of the sequent calculus. Double negations can be introduced in a later, optional encoding, which reconstructs the original CPS translation when composed with the alternative translation into LJQ. Therefore, the essence of compiling with continuations is indeed logical.

9 Viviani Spreafico and Paula Catarino. On a model of generalized $(k; p; s)$-Padovan-Perrin sequences

In this presentation, we introduce a model of generalized $(k; p; s)$-Padovan-Perrin sequences and provide some properties of the Fibonacci fundamental system related to this model. In addition, we give some identities, as well as combinatorial and analytical representations related to the sequences of this model.

10 José Carlos Costa. Asymptotic behavior of the overlap gap between left-infinite and right-infinite words

In a recent paper with Conceição Nogueira and M. Lurdes Teixeira, we investigated periodicity on infinite words. Given a left-infinite word λ, a right-infinite word ρ and a positive integer n, we define $g(n)$ to be n minus the maximum length of overlaps between the suffix of λ and the prefix of ρ of length n. We proved that the "overlap gap" function g has finite image if and only if λ and ρ are ultimately periodic words with a same root. In this talk we consider the asymptotic condition $\lim g(n)/n = 0$. We will report on our very recent joint work that proves that this asymptotic condition gives another characterization of words λ and ρ for which the overlap gap function has finite image.

11 Pedro Patrício. A note on tensor equations

A tensor is a multidimensional array. A first-order tensor is a vector, a second-order tensor is a matrix, and tensors of order three or higher are called higher-order tensors. In this talk, I will address operations on tensors and a rank decomposition. Relations to generalized invertibility will be approached.