Rui Ralha

TITLE: Eigenvalues and eigenvectors: history, algorithms and applications

ABSTRACT: The calculation of eigenvalues and eigenvectors plays a crucial role in scientific computing. A classical application is the so-called modal analysis of a mechanical stucture, like tall buildings or suspended bridges (*vibrations are everywhere and so too are the eigenvalues, or frequencies, associated with them*). More recent applications are, for instance, the Google's algorithm PageRank and the Principal Component Analysis. The earliest numerical method for computing eigenvalues and eigenvectors dates back to work of Jacobi in the middle of the the 19th century but it was the introduction of eletronic computers around 1950 that started intensive research in this area of numerical linear algebra that is still going on today. In this talk, we will present (without too many technical details) the main algorithms, considering their mathematical essence and also looking at how these have been influenced by the tecnological development of computers.

Carla Ferreira

TITLE: Eigenstructure of Wilkinson test matrices

ABSTRACT: In the 1950s J. H. Wilkinson introduced two classes of symmetric tridiagonal integer matrices. Most of the eigenvalues are close to diagonal entries (integers to visual accuracy) and each matrix illustrated subtle difficulties in the automatic computation of eigenvectors and eigenvalues. The structure of the eigenvectors of these matrices reveals that nearly all of them have the same shape, visually. More precisely, the interior eigenvectors are displaced versions of each other and the typical visual support of their normalized envelopes is like twin peaks. We will analyze the eigenstructure of these matrices and we will also discuss what happens when the order of the matrices reaches infinity.

José Carlos Espírito Santo

TITLE: Introduction to orthologic

ABSTRACT: Orthologic, also known as minimal quantum logic, is the logic of ortholattices, in the same way as quantum logic (resp. classical logic) is the logic of orthomodular ortholattices (resp. boolean algebras). In this talk, basic algebraic aspect of orthologic will be surveyed: a representation of ortholattices that is derived from the Kripke semantics of the logic; a semantic proof of decidability; and some surprises in the Lindenbaum algebra, found in the literature about the "anomalies" of the logic, which entail that the first sentence of this abstract is false.

Maria Antónia Forjaz, António Mário Almeida, T. de Lacerda–Arôso and Jorge Pamplona

TITLE: Addressing a geological conjecture as a Quadratic Eingenvalue Problem

ABSTRACT: Often in geological processes, such as layering, folding and boudinage, materials with contrasting physical properties are in contact. Understanding inter and intralayer contact dynamics is a primal step to solve some complex geological problems.

Traditionally, symmetric and asymmetric boudinage are accepted to be generated by extensional processes

only. But field observations of diverse asymmetric boudin formation stages seem not to be consistent with this canon, which has led to the conjecture that these bodies (in particular shearband boudins) are generated by an initial folding followed by an extensional behaviour showing C'S surfaces (accommodation shears).

To describe the dynamics of continuous geological mass systems, a 2-D model of a discrete set of point masses behaving as coupled oscillators has been developed from scratch. A finite element method (FEM) is used to calculate ab initio the behaviour of the whole system under the action of external forces and how it accommodates strain, taking into account inertia, elasticity, viscosity and damping. The matrix formulation of these physical parameters in the perspective of a second order differential dynamical equation has been employed to address the departing conjecture as a quadratic eigenvalue problem.

This presentation introduces the building out of the model till the present stage.

Pedro Patrício

TITLE: Stabilizer Formalism for Error Correction

ABSTRACT: In this exploring talk, we will present stabilizer codes and how to create quantum error correcting codes using classical codes.

Suzana Gonçalves

TITLE: Maximal subsemigroups of infinite symmetric groups

ABSTRACT: In [3], Hotzel gives a brief summary of what was known about maximal subgroups of G(X) in 1995. In [1], Brazil, Covington, Penttila, Praeger and Woods provide a new family of maximal subgroups of the symmetric group G(X) defined on an infinite set X. Since then, maximal subgroups of G(X) have been extensively studied, in particular when X is infinite. For this later development, see [2] and the references therein.
In [3], Hotzel remarks that some maximal subgroups of G(X) are also maximal as subsemigroups of G(X). For example, in [2] section 10, the authors provide several examples of such maximal subsemigroups of G(X). In this seminar we will provide infinitely many examples of non-group maximal subsemigroups of G(X).
We observe that, in many cases, G(X) is not isomorphic to G(V), the general linear group on an infinite-dimensional vector space, even though their algebraic properties are similar, for example, the description of some of their maximal subsemigroups that we will also discuss in this talk.
A linear version of results in [1] and [2] concerning maximal subgroups of G(X) is planned for future research.
1. M. Brazil, J. Covington, T. Penttila, C. E. Praeger and A. R. Woods, Maximal subgroups of infinite symmetric groups, Proc. London Math. Soc., 68 (1)(1994) 77-111.
2. J. East, J. D. Mitchell and Y. P´eresse, Maximal subsemigroups of the semigroup of all mappings on an infinite set, Trans. Amer. Math. Soc. 367 (3)(2015), 1911-1944.
3. E. Hotzel, Maximality properties of some subsemigroups of Baer-Levi semigroups, Semigroup forum, 51 (1995) 153-190.

Yulin Zhang

TITLE: A TP matrix comes from Bernstein basis

ABSTRACT: A special TP matrix will be introduced, then an unsolved problem will be proposed.

Bruna Calisto (Mestrado em Matemática e Computação)

TITLE: A Proof of the Standardization Theorem in the λ-Calculus

ABSTRACT: In this talk we will address the standardization theorem in the lambda-calculus. This theorem is a fundamental result in the theory of reduction of the lambda-calculus and roughly says that one term t reduces to another term t' if and only if t reduces to t' following a specific sequence of reductions said "standard". We will sketch a proof of this result which follows a proof of a standardization theorem in a lambda-calculus for a fragment of the intuitionistic modal logic IS4, develop by Espírito Santo-Pinto-Uustalu. We will also illustrate some preliminary steps towards the formalization of this proof in the Coq proof assistant.

Catarina Sousa (Mestrado em Matemática)

TITLE: Minimal Quantum Logic: a brief comparison with Classical Logic

ABSTRACT: Semantically, Classical Logic (CL) is associated with Boolean algebras, while Minimal Quantum Logic (MQL) is associated with ortholattices, which are lattices where, notably, the distributive laws are not necessarily true. Deductively, when employing the sequent calculus, one has to impose restrictions on the inferences rules of QML, notably on the cut rule, in order to prove fewer theorems. Examples will be presented.

Maria Merceana Pereira (Mestrado em Comunicação de Ciência)

TITLE: Science Communication at the Military Museum of Porto

ABSTRACT: Created in 2019 the Master in Science Communication, by UMinho, a partnership between ICS and ECUM, aims to promote critical thinking in master students about the challenges and possibilities of science communication, as well as to providing multidisciplinary knowledge to enable them to carry out an intervention or an in-depth investigation in this field. This duality between theory and practice will guide our talk in the sense that, starting from the presentation of the above mentioned Master in Science Communication, we will present the work that has been developed at the Military Museum of Porto, focusing in particular the design and development of inclusive science learning activities.

Anderson Beraldo-de-Araujo (Doutoramento em Matemática)

TITLE: A postulative proof calculus

ABSTRACT: In this talk I shall introduce a *postulative proof calculus* for classical logic, capable of characterizing both consistency and provability of formulas, two concepts that can be conceived as the

syntactic counterparts of the semantic concepts of satisfiability and validity, respectively. *Postulates* are sequents with just one atomic formula: the poles have one occurrence of the formula either to the left or to the right, whereas the *axioms* have one occurrence of it in both sides. Hence, there are two notions of proofs: *verificative proofs* are built from poles, *demonstrative proofs* are built from axioms (actually in line with Poincare's distinction between *verifications* and *demonstrations*). From a foundational standpoint, I shall indicate how a postulative proof calculus allows to prove syntactical versions of the pressupositions of model theory about assignments, a problem on Tarski's semantic method observed by Dummett, and recently studied by Restall. As a potential application of the postulative proof calculus, I shall sketch some ideas envisaging its extension to represent algebraic group structures, and the use of such an extension to analyse the computational complexity of checking and solving systems of equations over finite permutation groups.

Angelos Bampounis (Programa Doutoral em Matemática Aplicada)

TITLE: Matchgate circuits with magic resources for universal quantum computation

ABSTRACT: It is believed that quantum computers are more powerful and offer the possibility of dramatic speed-up relative to their classical counterparts. A promising approach to understand their power is to study restricted classes of computation which can be efficiently simulated by classical devices but become quantum-universal by the addition of an extra resource. Such a resource may then be regarded as the source of the quantum advantage. A way to explain the power of this recourse is to look for some non-classical features that might display. Two characteristic signs of non-classicality are the notions of quantum contextuality and negativity of Wigner function. One of the most prominent examples is stabilizer circuits, the class of circuits built out of Clifford gates, which according to the Gottesmann–Knill theorem can be classically efficiently simulatable, and can be promoted to quantum universality via the so-called magic state injection. In the framework of stabilizer sub-theory, it was shown that the physical property that magic states exhibit to serve as universal resources is that of quantum contextuality in the case of qudits (d-dimensional quantum systems) with d an odd prime power.
In this talk, I will be talking about the main subject of my research project which is another interesting restricted class of circuits, which can be classically efficiently simulated, made out of a special set of unitary two-qubit gates restricted to act on nearest-neighbour (n.n.) qubits, the so-called matchgates. We will also see an interesting aspect of which is their correspondence to quantum evolutions of non-interacting ("free") fermionic quantum computation via the so-called Jordan-Wigner transformation which gives a map between fermions and qubits. In addition, we will see the ways with which matchgate circuits can be promoted to quantum universality. Finally, I will discuss about my work in progress and future research plans.