ANNOUNCEMENT FOR THE AWARD OF A RESEARCH FELLOWSHIP

Research Fellowship - 6 vacancies

25/ECUM/CMAT/2024 - UIDB/00013/2020

A call for applications is now open for the attribution of 6 (six) grants of master's degree within the scope of the R&D project UIDB/00013/2020 – Basic Funding of the Centre of Mathematics (CMAT) of the School of Sciences of the University of Minho, financed by national funds through Fundação para a Ciência e Tecnologia, under the following conditions:

Scientific Area: Mathematics

Recipient category: It is intended for carrying out R&D activities by students enrolled in degree courses as master's in Mathematics, Computer Science or Statistics.

Requirement for granting the fellowship:

- The applicants may apply without prior registration in the course for which the fellowship is open. The requirement to enrol in a degree course or non-academic degree course will be verified on the date of contracting the fellowship;
- Only fellowships whose selected applicants present a valid proof of enrolment in a degree course or non-academic degree course will be contracted, according to the type of the fellowship, issued by the academic services of the Higher Education Institution, indicating, respectively, the academic year or its duration (start and term).

Candidates profile: The candidates must have a profile that fits the research activities foreseen in the research project(s) to which they are applying. The 18 (eighteen) projects in this call are listed where, in particular, the candidate profile of each project is described.

Applicants eligibility: Applicants must comply with the eligibility conditions laid down in article 9 of the Research Grants Regulation of the Portuguese Foundation for Science and Technology (2019).

Workplan and objectives to be achieved: It is intended that the fellowship researcher collaborate in the research activities of CMAT, integrating one of the projects whose description and supervisors are indicated below, including the corresponding target audience. The candidate must mention up to 3 (three) references of projects for which he/she is applying, in descending order of preference, chosenfrom among the following 18 (eighteen) projects:

PROJECT BI2024-A	Regression models for longitudinal data
SUPERVISOR	Inês Sousa (isousa@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Statistics for Data Science
WORK PLAN	Statistical models designed for longitudinal data are well-suited for analyzing datasets comprising repeated measurements over time

across multiple individuals (persons or other individual units). Within the realms of life and health sciences, as well as in business contexts, the existence of extensive databases for investigating the temporal progression of specific markers (random variables) is commonplace. This project proposes an examination of these longitudinal models applied to datasets within a scientific domain, juxtaposing the inferences drawn with those derived from alternative statistical models.

PROJECT BI2024-B	Inverse function theorem
SUPERVISOR	José Manuel Ribeiro Oliveira (jmo@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	It is well known that the inverse function theorem states that a smooth mapping, in which its derivative at a point of its domain is a linear isomorphism, admits a restriction which is a diffeomorphism. When the derivative of the mapping is not necessarily bijective, it is also possible to characterize properties of the mapping under lighter hypotheses such as surjective derivative or injective derivative. This work embraces the study of some properties of smooth mappings between two smooth manifolds in which its derivatives are injective mappings or surjective mappings, enhancing the construction of submanifolds as inverse images of regular values of smooth mappings.

PROJECT BI2024-C	Risk analysis and portfolio classification using neural networks
SUPERVISORS	Irene Brito and Gaspar J. Machado (ireneb@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation or the Master in Statistics for Data Science
WORK PLAN	The aim of this project is to analyse the risk of stocks and to study the applicability of neural networks to classify stocks. The stocks are analysed using different risk measures and neural networks are applied to predict the risk. The portfolios built from the selected stocks will then be analysed using performance measures. The objective is to determine the most appropriate risk measures and to construct efficient neural networks in order to maximize the portfolio's return. The models will be applied to different stock market indices (PSI, Eurostoxx50, DJIA).

PROJECT BI2024-D	Decision models for extreme risk
SUPERVISORS	Irene Brito and Marta Ferreira (msferreira@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Statistics for Data Science or the Master in Mathematics and Computation
WORK PLAN	Risk assessment and decision making are important requirements in diverse areas such as finance, actuarial science, environment, engineering, health, among many others. On the other hand, the occurrence of extreme phenomena inevitably impacts daily life and human action. The aim of this project is to study decision models, incorporating risk measures associated with the occurrence of extreme values. An application to real data is also aimed (for example to the financial or actuarial context).

PROJECT BI2024-E	Risk of contagion of large losses
SUPERVISOR	Marta Ferreira (msferreira@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Statistics for Data Science or the Master in Mathematics and Computation
WORK PLAN	Extreme Value Analysis (EVA) is an expanding field, given the growing need to assess the risk of occurrence of extreme events, in areas such as economy, engineering, environment, etc. In financial systems, the phenomenon of globalization and reduced supervision make markets vulnerable and interdependent. It is vital to evaluate/quantify the risk of "contamination", particularly for the occurrence of large losses. EVA focuses on extreme dependence measures that allow for inference of such risk. The aim of this study is to analyse and apply estimation methods in this context.

PROJECT BI2024-F	Numerical time schemes
SUPERVISORS	Maria Teresa Malheiro and Gaspar Machado (mtm@math.uminho.pt)
TARGET AUDIENCE	Students of a Master in Mathematics, Computer Science or Statistics.
WORK PLAN	In simulations inherent to battery charging, differential equations in which time is an independent variable, are used. In this work,

students will study numerical methods applied to this type of differential equation. These schemes must have characteristics such as considering that the time variable only has one direction, implying that the scheme is progressive. On the other hand, the time parameters, in particular the time step, are strongly conditioned by the need for the scheme to be stable. This is a very restrictive condition that often requires very small time steps, affecting the efficiency and computational cost of the scheme.

PROJECT BI2024-G	Generalized Collocation Methods and Applications
SUPERVISORS	M. Irene Falcão and Fernando Miranda (mif@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	This work proposes a comprehensive study on Generalized Collocation Methods (GCM) and their application in practical contexts. GCMs are a class of numerical methods widely used to solve problems involving partial differential equations and integro-differential equations. The main objectives of this work include the exploration of the theoretical foundations of GCMs, their computational implementation, and their specific application to relevant problems in applied sciences.

PROJECT BI2024-H	Homotopy theory
SUPERVISOR	Thomas Kahl (kahl@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	Homotopy theory is a branch of algebraic topology that studies the continuous deformation of topological spaces and continuous maps. Methods from homotopy theory continue to play a central role in current research in algebraic topology. The purpose of this project is to develop the fundamental ingredients of homotopy theory and to provide the student with the most relevant techniques used in research in this area. The topics to be studied are homotopy equivalences, fibrations and cofibrations, homotopy groups, exact homotopy sequences, CW complexes, and model categories.

PROJECT BI2024-I	A mathematical model of a drug-induced tumour inhibition

SUPERVISORS	Davide Cusseddu and Ana Jacinta Soares (davide.cusseddu@gmail.com)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation or the Master in Statistics for Data Science
WORK PLAN	Mathematical models might be compelling in biological and pharmacological applications. In this project, we are interested in deriving a mathematical model for studying the inhibiting effects of a two-drug combination in hepatocellular carcinoma metastasis. The final goal is to estimate optimal drug doses that maximise tumour inhibition, by combining analytical and numerical tools. The student is expected to be comfortable in working with ordinary differential equations, performing numerical simulations, and to have an interest in collaborating with biologists.

PROJECT BI2024-J	The chaotic dynamics of the quadratic function and the Smale horseshoe
SUPERVISOR	Davide Azevedo (davidemsa@gmail.com)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	The quadratic function, despite its simple appearance, has a very rich dynamic. The aim is to study this dynamic system for certain parameters, using the shift function, symbolic dynamics. The "shift" behavior is much simpler to study and it will be seen that it has a dynamic "equal" to the quadratic in a certain set. Then we will look at Smale's horseshoe, a function of a two-dimensional domain that stretches it in one direction, shrinks it in the other and bends it into a horseshoe shape. For this, similar ideas will be used, using another "shift".

PROJECT BI2024-K	Supervised statistical learning methods under spatial or temporal correlation
SUPERVISOR	Raquel Menezes (rmenezes@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Statistics for Data Science or the Master in Mathematics and Computation
WORK PLAN	Supervised statistical learning methods typically assume independence among observations. However, when data is collected within a specific region or period, this assumption may become invalid. This work aims to explore machine learning methods, particularly decision trees, to handle spatially or temporally correlated data. Additionally, the research intends to evaluate the availability

	and suitable of R packages for implementing these methods, applying them to real-world case studies to demonstrate their utility and effectiveness.

PROJECT BI2024-L	Dynamic models in the modelling of environmental time series data
SUPERVISORS	Arminda Manuela Gonçalves (CMAT) and Marco Costa (CIDMA) (mneves@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Statistics for Data Science or the Master in Mathematics and Computation
WORK PLAN	In this study, dynamic models will be proposed to analyse and evaluate the temporal evolution of surface water quality in a river basin. The aim is to identify trends, seasonality, and possible changes in water quality through a dynamic monitoring procedure. The multidimensional nature of data requires multivariate statistical analysis, enabling the identification of complex patterns and unobservable structures, essential for understanding the dynamics of the phenomena under study.

PROJECT BI2024-M	Evaluating Machine Learning on Large and Small Datasets with a Large-Scale Ground Reaction Force Dataset
SUPERVISOR	Flora Ferreira (fjferreira@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	The analysis of ground reaction forces (GRF) is crucial for understanding the biomechanics of gait in both healthy individuals and patients with gait disorders. The "GaitRec" dataset, released in 2020, offers a vast collection of GRF data from over 2000 individuals, including healthy participants and those with four different types of gait disorders. This dataset provides a good opportunity to explore how different machine learning techniques perform on datasets of varying sizes. The objective of this dissertation is to evaluate and compare the performance of machine learning techniques when applied to datasets of different sizes using the GaitRec dataset.

PROJECT BI2024-N	Data Science for sustainable urban mobility
SUPERVISORS	Fernanda Costa and Flora Ferreira (mfc@math.uminho.pt, fjferreira@math.uminho.pt)

TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	Sustainable mobility in cities is crucial for the economy, the environment, and society, promoting carbon neutrality. This project applies data science methods to manage a fleet of light electric vehicles in an urban environment. Machine learning algorithms will be developed based on real mobility data, including inertial data, location (GPS), and CAN (engine information and other relevant vehicle systems). Applications include estimating braking force to monitor brake wear and detecting driving anomalies, signaling improper driving or road issues.

PROJECT BI2024-O	Automated and Optimized Scheduling for CNC Machines
SUPERVISOR	Fernanda Costa (mfc@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	This project aims to design and implement a system to solve a real industrial problem: automating and optimizing the weekly production schedule of CNC machines in a factory in Portugal. The objective is to replicate and enhance the existing manual scheduling process by integrating multiple data points and developing a mathematical model (MILP) alongside optimization algorithms. This approach aims to generate optimized solutions that reduce machine downtime, minimize tool change frequency, and decrease operator workload. This project has the collaboration of Filipe Marcelo Ferreira Alves from DTx (Digital Transformation CoLab) , University of Minho.

PROJECT BI2024-P	Generalized Linear Mixed Models
SUPERVISORS	Susana Faria and Luisa Novais (sfaria@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Statistics for Data Science
WORK PLAN	Generalized Linear Mixed Models (GLMMs) are particularly useful for describing the relationship between a response variable and one or more explanatory variables in grouped data according to one or more factors, such as longitudinal data, repeated measurements, and data with a hierarchical structure. This study aims to address the problem of parameter estimation and variable selection in GLMMs. Additionally, we intend to apply these models to a real dataset.

PROJECT BI2024-Q	A variant of lambda-calculus for the extension of the Curry-Howard isomorphism to sequent calculus
SUPERVISORS	José Carlos Espírito Santo and Luís Pinto (jes@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	The Curry-Howard isomorphism relates natural deduction and the simply-typed lambda-calculus. One proposal to extend the isomorphism to the richer setting of sequent calculus is a variant of the lambda-calculus, studied in CMAT in the last two decades, where the concept of argument in functional application is generalized along two dimensions: one encompassing general elimination rules, another allowing functions to be called with more than one ordinary argument. The goal of the project is to introduce the student to this system and formalize some of its meta-theory in the Coq proof assistant.

PROJECT BI2024-R	Clifford groups in quantum computing
SUPERVISORS	Pedro Patrício and Rui Soares Barbosa (INL) (pedro@math.uminho.pt)
TARGET AUDIENCE	Students of the Master in Mathematics and Computation
WORK PLAN	Clifford groups were introduced in the field of quantum error-correcting codes by D. Gottesmann in 1998. In a quantum computer, some fault-tolerant coding is required, particularly for memories and quantum gates. One way of correcting these faults is to use error-correcting codes. The no-cloning theorem could indicate that classical codes would be unfeasible in this paradigm. However, stabilizer codes show that it is possible to systematically construct quantum error-correcting codes using classical codes. An important group of transformations in this context is the Clifford group: it is the normalizer of the group of generalized Pauli matrices, a subgroup of the unitary group (of degree 2^n). The aim is to carry out a study of the state of the art of the subject, such as the impact of the approach on quantum computing using the Clifford group.

28; Regulation of Scientific Research Fellowships of the University of Minho (RBIC), published in "Diário da República", 2nd series, no. 119, through dispatch no. 6524/2020 of 22-06-2020, ratified by ratification declaration no. 447/2021 of 22-06-2021 and Regulation of Research Studentships and Fellowships (RBI) of the Foundation for Science and Technology, I.P. - in force.

Host/Contracting institution and scientific supervision: The workplan will be carried out in Centre of Mathematics of University of Minho, located in the Campus of Gualtar or Campus of Azurém, under the scientific supervision of the member(s) of CMAT who proposed the research plan for which the candidate was selected.

Fellowship duration: The grant will take place for a period of 3 months, with a provisional starting date in October 2024. The fellowship grant may eventually be renewed up to 3 months, subjet to approval by CMAT.

Amount of the research grant: The value stipend (Monthly Maintenance Allowance) is 990,98 euros per month, in accordance with the stipends values published by the Foundation for Science and Technology (FCT I.P.) in the country (Annex I – Monthly Stipends Values for the maintenance allowances of the [FCT Regulation for Research Studentships and Fellowships](#)) and Annex II of the Regulation of Scientific Research Fellowships of the University of Minho (RBIC), published in "Diário da República", 2nd serie, no. 119, through dispatch no. 6524/2020 of 22-06-2020, ratified by ratification declaration no. 447/2021 of 22-06-2021, according to the applicable regulation.

Payment is made on the 23rd of each month, through bank transfer to the Bank Identification Number of the fellow identified in the contractualization process.

Other benefits: Reimbursement of Voluntary Social Security (Social Security contributions), corresponding to the 1st level of discounts *(for research grants with a total duration 6 months or higher)* and personal accident insurance.

Exclusivity regime: The grantee will perform the activities under exclusivity, as foreseen in article 5 of the Research Fellow Statutes and applicable regulations.

Selection panel:

President:

Maria Suzana Freitas de Sousa Mendes Gonçalves, CMAT member, Assistant Professor at the Department of Mathematics, School of Sciences, University of Minho;

Effective members:

Maria Conceição Soares Serra, CMAT member, Assistant Professor at the Department of Mathematics, School of Sciences, University of Minho;
Ângela Carla Ferreira Macedo, CMAT member, Assistant Professor at the Department of Mathematics, School of Sciences and Technology, University of Trás-os-Montes e Alto Douro

Substitute members:

José Joaquim Martins Oliveira, CMAT member, Assistant Professor at the Department of Mathematics, School of Sciences, University of Minho;
Maria de Lurdes Azevedo Teixeira, CMAT member, Assistant Professor at the Department of Mathematics, School of Sciences, University of Minho.

The first effective member will substitute the President of the selection panel in case of impediment, being nominate the first substitute member in the place of the first effective member.

Criteria and procedures for applications assessment and selection: The applications assessment will focus on the candidate's Merit, following evaluation criteria, valued on a scale of 1 to 5 values:

Applicant Merit - AM:

Academic path (considering the classifications of academic degrees), with a weighting of 50%;

A1. Personal curriculum (considering professional and scientific background), with a weighting of 30%
A2. Motivation letter, with a weighting of 20%.

The final classification of the **Applicant's Merit (AM)** will be achieved through the following formula:

$$AM=(A1*0,5) + (A2*0,3) + (A3*0,2).$$

Applicants with an AM score of less than 3,5 will not be eligible for a research grant. If the jury considers it convenient, candidates with a minimum classification of 3,5 in the AM will be admitted to the Interview stage, with the Jury proceeding to assess the following sub-criteria:

Interview – INT:

B1. Interpersonal skills (30%);

B2. Demonstrated knowledge in the area (20%);

B3. Motivation (40%);

B4. Linguistic competences (10%).

The **Interview classification (INT)** will be obtained by applying the following formula:

$$INT=(B1×0,3) + (B2×0,2) + (B3×0,4) + (B4×0,1).$$

If an interview takes place, the Final Classification (FC) of the Applicant Merit (AM) and Interview (INT) will be obtained by applying the following formula:

$$FC=(AM×0,7) + (INT×0,3).$$

If there is no interview, the final classification (CF) will coincide with the Applicant Merit (AM):

FC=AM.

The academic degrees and diplomas documents, or their respective recognition when awarded by foreign higher education institutions, are not mandatory in the application phase, being replaced by a declaration of honour of the candidate with the contents of academic results. The documents of academic qualification or respective recognition will be required in the contracting phase and must attest facts that occurred on a date prior to the application. In situations of divergence between the information contained in the declaration and the documentation submitted for contracting the grant, only the information contained in the latter will be considered. If the documents proving the ownership of the academic degree and diploma, or the respective recognition under the terms of Decree-Law No. 66/2018, of August 16, do not correspond to the classifications awarded in the evaluation of the academic path, which can change the candidate's ranking, the fellowship won't be contracted.

Notes: Applicants with degrees obtained abroad must present proof of recognition of qualifications in Portugal and conversion of the final classification obtained in them to the Portuguese classification scale or declaration under the terms indicated in the previous point. Candidates who do not comply with one of these provisions, the selection panel will assign "0" in the grade of the graduation and/or master course. Candidates will be evaluated on the remaining parameters.

Disclosure of results: The provisional results of applications, based in the selection panel minutes, will be sent to the applicants by email until 90 working days from the applications deadline.

If case of unfavourable results, the candidates have a period of 10 working days to comment, if desired, in a prior hearing to interested parties, pursuant to articles 121 and 122 of the Code of Administrative Procedure (DL no. 4 / 2015 of January 7).

[The hearing of the interested parties, if excluded, should be justified accordingly with article 124º of CPA]

Complaint and appeal procedures: The final results of the evaluation will be published through an ordered list (*alphabetically, by final grade obtained*), posted in a visible and public place of the host unit, as well as by email to all applicants, enclosing for that purpose the minutes of the jury deliberations.

The selected candidate must inform its willingness to accept the grant, in writing. In case of rejection, the fellowship will be awarded to the next candidate in the ordered list of applicants, bearing in mind that a candidate who has been awarded a grant may exchange the associated project for another with a higher preference in the choice expressed at the time of their application if that project is no longer associated with an accepted grant.

The final decision can be contested within 15 working days, by sending to the President of the jury the corresponding claim. Interested parties may also submit an optional hierarchical appeal, in the terms of number 2 of article 15 of Regulation of Scientific Research Fellowships of the University of Minho (RBIC).

Constitution of a selection reserve list: The applicants ranked in the next positions on the ordered list will be included in a selection reserve list, which can be used until 31/12/2024.

Application deadline and submission: The tender is open for a period of 10 working days, counting from the date of publication of the advertisement on the Euraxess portal.

Applications must be formalized by sending an application letter with the following documents: curriculum vitae; qualifications certificate or declaration of the applicant; motivation letter; statement proving that meets the conditions for the grant typology, according to the application requirements; other documents important to the evaluation process).

Applications must be sent by email to bolsas@ecum.uminho.pt, indicating the reference of the call for applications in Subject: **25/ECUM/CMAT/2024 - UIDB/00013/2020**. Applications submitted by other means will not be accepted.

Fellowship contractualization: The fellowship will be attributed by signing a fellowship contract between the University of Minho and the fellow, accordingly with the contract minute (annex IV of the Regulation of Research Fellowships of the University of Minho (RBIC), published in *Diário da República, 2nd Série, no. 119*, through dispatch no. 6524/2020 of 22-06-2020, ratified by ratification declaration no. 447/2021 of 22-06-2021, as indicated in 2.4 of the FCT document: "[Rules for Granting and Management of Grants within the scope of R&D projects, including infrastructure projects, the multi-annual financing program for R&D units and other FCT financing instruments (Version 2021)](#)".

The contract may only be concluded after all the documentation required is collected, which must take place within a maximum period of 6 months [including evidences of the academic degrees or diplomas and enrolment in degree courses or non-conferring courses, depending on the type of scholarship].

Once all the documentation has been received, the contracting entity has a period of 60 working days to conclude the scholarship contract. Once received, the fellow must return the contract duly signed within 15 working days.

The activities under the fellowship contract can only began after proper authorization by the contracting entity.

Term and cancellation of fellowship contracts: Without prejudice to the other causes provided the fellowship regulations (FCT and UMinho) and in the Statute of the Research Fellow, the fellowship ends with the completion of the work plan, as well as with the expiration date for which it was granted or renewed.

At the end of the fellowship, the grantee is obliged to present a Final Report of the work carried out, in accordance with the objectives and evaluation criteria defined with the scientific advisor, within 30 days after the end of the scholarship.

The **final report** must be prepared in accordance with Annex I of the Scientific Research Fellowships Regulation of the University of Minho (RBIC), published in *Diário da República, 2nd*

Série, no. 119, through dispatch no. 6524/2020 of 22-06-2020, ratified by ratification declaration no. 447/2021 of 22-06-2021.