

2020/2021 MIT Portugal Program PhD Candidates



MIT Portugal Program

The MIT Portugal Program (MPP) is an international partnership that aims to foster collaborative research between the Massachusetts Institute of Technology (MIT) and Portuguese universities, research institutes, laboratories and companies. MPP has a problem-solving culture which nurtures innovative ideas to tackle global challenges in strategic areas for our planet: Climate Science and Climate Change, Earth Systems: from Oceans to Near Space, Digital Transformation in Manufacturing, and Sustainable Cities, anchored to Data Science.

The beginning of MPP

Since 2006, MPP has facilitated top-quality educational and research opportunities for students, researchers, faculty, and industry partners, contributing to strengthening the Portuguese academic and industrial ecosystem, and building a more sustainable environment, economy, and society.

A new vision

In 2018, a new phase of MPP began – the MPP2030 – with a new vision, but still keeping the mission of investing in the development of human capital. Hence, the Program signed a collaboration protocol with Fundação para a Ciência e Tecnologia (FCT) to award up to 40 PhD research grants per year over the next 3 years. As a result, the first call was opened in 2020.

This booklet presents the MPP PhD Candidates selected in the 2020 call.

Here you can learn more about these students and how their projects will contribute to strengthen Portugal in key strategic areas for our society, and with international relevance.

To everyone who contributed to this Booklet our most sincere gratitude.

MPP Program Directors



Pedro Arezes



Zita Martins



Doug Hart



R. John Hansman

Welcome

Welcome MPP PhD candidates! We have great expectations about your work! You are now part of a very special community, encompassing diverse academic and geographic backgrounds, but sharing common goals and values. Therefore, we would like to encourage you - our PhD candidates - to take the most of this network. Be curious, be attentive to the problems that society is facing, and be creative in researching solutions to tackle them!

One of the flagships of the MIT Portugal Program (MPP) has been the training of highly qualified human resources, offering education initiatives that improve their minds and knowledge.

During the past 15 years, supported by the Fundação para a Ciência e Tecnologia (FCT) and in collaboration with Portuguese Universities, we have launched 7 PhD and Master Executive Programs, fostering more than 1100 students, with over 490 graduated students. Most of these students are now making a difference in different sectors of society. Some are in Academia as scientists or professors, others created start-ups, and others went to industry.

To strengthen the impact of the MPP, the current phase of the Program (2018-2023) brought a significant shift in the education programs. Together with FCT, the MPP is opening a call, every year, to fund up to 40 PhD candidates who will conduct research in one of the strategic areas supported by MPP: Earth Systems, Digital Transformation in Manufacturing, Sustainable Cities, Climate Science, and Data Science. By applying for this scholarship, students may enroll in any Doctoral Program of a Portuguese University that better suits their research plan, and also be part of the MPP community.

We are proud of our alumni community and all the impact they are having on our society. We continue our mission to contribute to the Portuguese innovation ecosystem, by reinforcing the links between academia and industry, and between creative minds, whether they are students, senior researchers, or practitioners.

Scientific Areas of Research

Throughout the publication, the different scientific research areas of the MPP, will be signalled by icons, as illustrated.

Climate Science & Climate Change



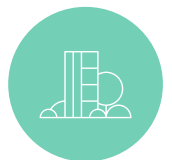
Earth Systems: Oceans to Near Space



Digital Transformation in Manufacturing



Sustainable Cities



Data Science



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Development of optimized compressed earth blocks

Granting Institution: School of Engineering, University of Minho

Supervisor: Ricardo Mateus Co-Supervisor: Elisabete Teixeira



Currently, with the growing concern in adopting more sustainable technical solutions, the interest in Earth as a building material has been renewed. The present proposal has as main objective the development of compressed earth blocks (CEBs) capable of meeting the requirements of safety, durability, comfort and hygiene proportional to the expectations of the modern world, contributing to the circular economy. Thus, it is expected to optimize the thermal behavior of the CEBs from the incorporation of low-cost natural materials and to study the incorporation of construction and demolition waste (CDW), without neglecting the optimization of its mechanical and structural performance. The desired products will represent more economical solutions, with reduced environmental impact, in a perspective of contribution to sustainable development. The results of the study will assist professionals who intervene in the rehabilitation and conception of new buildings using earthen construction.

“The MPP-FCT fellowship represents an opportunity to establish a relevant study on the path to sustainable construction and to develop products that improve the environmental and economic performance in the field of civil construction, contributing to the Circular Economy.”



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Energy, Materials and Health in regenerative processes of common architecture for Sustainable Cities

Granting Institution: Faculty of Architecture, University of Porto

Supervisor: José Pedro Sousa Co-Supervisor: Rui J. G. Ramos



The Intergovernmental Panel on Climate Change urges industries to disrupt with changes. From design to build takes years and decades to operate, making it a long-lasting machine that has a large impact on the climate and biodiversity, and could be thought to regenerate the environment. The International Style, developed at the beginning of the 20th-century, paid no interest to climate or past knowledge. The digital turn in architectural design — computer simulation and performance optimization allows not only creating ideas and processes but also revisiting vernacular, historical, early-modern and counter-culture architecture and with accurate tools in the search for solutions for better daylight conditions, energy consumption or ventilation. This proposal looks for regenerative architecture schemes in three domains (Energy, Materials and Health) for rapidly changing: retrofitting and urbanizing, regions and those researching borders concepts like tradition/innovation, local/innovation to create a sustainable built environment. Finally, the proposal is in line with the New European Bauhaus and its local version the NEB Goes South that has been developed at the University of Porto and partners recently.

“MIT Portugal community can push the project with constructive critique and opens doors for future collaborations, with researchers in Portugal and in the USA.”



Adriano Silva

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Optimization of municipal solid waste management systems towards sustainability.

Granting Institution: **Faculty of Engineering, University of Porto**

Supervisor: **Hélder Teixeira Gomes** Co-Supervisors: **Ana Isabel Pinheiro Nunes Pereira, Adrián Manuel Tavares da Silva**



The project aims for the development of (i) data acquisition strategies for waste management systems, using the northeast of Portugal as a model region, and (ii) innovative technological solutions to valorise solid waste streams into carbon nanostructured materials (CNMs), with applicability in the treatment of leachate waters. Learning algorithms will be applied to characterize the waste, and optimization algorithms will be used to optimize waste transportation considering the consumer's behaviour. Regarding waste valorization, CNMs will be prepared from plastic solid wastes by chemical vapor deposition. These as-synthesized CNMs will be employed as precursors to produce catalysts and membranes for advanced oxidation and separation technologies to treat landfill leachates. The project will be conducted in collaboration with a waste management company (Resíduos do Nordeste) dealing with the municipal solid waste generated in the northeast region of Portugal.

"I am sure the opportunities offered by MPP will help me achieve my professional and personal goals."



Albano Martins

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Bioclimatic design in urban context through the recovery of vernacular solutions

Granting Institution: **Faculty of Engineering, University of Porto**

Supervisor: **Fernando Brandão Alves** Co-Supervisor: **Helena Corvacho**



The bioclimatic solutions of vernacular architecture and its principles of adapting the building to the climate constitute important lessons in constructive and environmental sustainability. Thus there is a strong correlation between construction and morphological characteristics and the respective local climatic contexts. Contemporary architecture ends up neglecting these issues to a certain extent, where traditional and empirical knowledge has been lost over time, as well as cultural identity, giving rise so often to constructions disconnected from the characteristics of the "region", and without sustainable basis in constructive and environmental terms.

This project intends to reflect on the advantages of recovering the empirical knowledge of vernacular construction, being able to serve as a guideline in the eventual creation of specific regulations. These guidelines are also suitable for application in countries with similar climatic characteristics, highlighting the traditional materials available locally and the techniques used in construction, together with the possibility of linking these constructive solutions to the contemporary technologies available.

"The interaction provided by the MPP-FCT fellowships can be very useful for exchanging ideas."



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Sludge treatment by earthworm-enhanced reed beds towards smart-cities

Granting Institution: School of Agriculture, University of Lisbon

Supervisor: Elizabeth Duarte Co-Supervisors: Ana Galvão, Rita Fragoso



The objective of this study is to demonstrate the potential of the sludge-treatment-reed-bed (STRB) assisted with earthworm as a sustainable solution for sewage sludge management within a smart city plan. This alternative solution can be used instead of conventional ones that are costly, low in life expectancy and by-products need further treatment.

This cost-effective project will be developed in cooperation with the water industry (Frielas wastewater-treatment plant) that will supply sludge samples and validate the benefits of this innovative technology. The project comprises earthworms' roles in sustainable sewage sludge management, dewatering and stabilization processes, evapotranspiration effect in the dewatering and the assessment of the operational requirements for STRB technology to develop a technical and economic evaluation analysis.

The knowledge gathered from this research will contribute to minimize environmental impacts of climate changes as well.

"I am happy to have the chance to be one of the grantees of the MPP-FCT scholarship and I hope to meet new people and gain knowledge on collaborative investigations and discussions."



Ana Luísa Reis

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Full integration of water and energy nexus in water supply systems

Granting Institution: Faculty of Sciences and Technology, University of Coimbra

Supervisor: Carlos Alberto Henggeler de Carvalho Antunes Co-Supervisor: António Gil Andrade-Campos



Water distribution systems (WDS) are energy-intensive infrastructures that rely on water storage plants and energy for delivering water to consumers. The combination of three complementary trends offer water companies opportunities for a novel positioning in the energy sector: the flexibility in scheduling pumping operations leading to implementing demand response (DR) strategies with benefits to water and energy utilities, current investments in renewable energy sources (RES), new dynamic pricing (DP) tariffs in smart grids. Therefore, this research aims to develop novel models and algorithms to cope with the increased complexity of real-time optimization of energy resources in WDS operation encompassing the management of DR actions, energy availability from RES, time-differentiated tariffs and participation in emerging energy markets. Mathematical programming models will be developed accounting for the network infrastructure of water and energy sectors, exploiting their synergies.



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Bio-inspired gyroid foams by machine learning optimization and meshless methods

Granting Institution: Faculty of Engineering, University of Porto

Supervisor: Jorge Américo Oliveira Pinto Belinha

Co-Supervisor: Fernando Jorge Lino Alves



The aim of PhD project is to conceive improved bone implants and prosthesis based on the gyroid structure. Gyroid foams allow to obtain suitable mechanical properties to mimic human bone contributing to the performance of the implant in the patient. To do so, innovative tools such as machine learning will be used. Moreover, it is important to mention that the gyroid structure can be used for structural purposes, and thus, build lighter yet structurally sound parts.

“Being in this program allows us to more easily meet other people in different areas and to exchange ideas and knowledge.”



André Cardoso

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Framework for ergonomic assessment in collaborative robotic systems

Granting Institution: School of Engineering, University of Minho

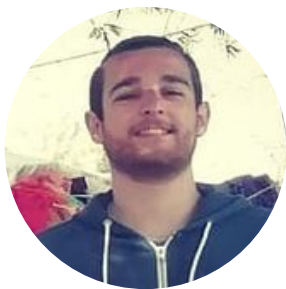
Supervisor: Ana Colim Co-Supervisors: Estela Bicho, Ana Cristina Braga



The potential of Human-Robot Collaboration (HRC) is far from exhausted. Currently, Collaborative robots (COBOTs) are advertised for ease of commissioning and the capacity to operate without fencing, and thus share the workspace with humans. Even when the COBOT is programmed to admit some degree of interaction with the worker, the robot system is “socially blind” to Ergonomics & Human Factors (E&HF). The lack of a valid and sound ergonomics framework cognizant of the implications of HRC, as well as the inexistence of a correlation between risk assessment/prevention and complementary robot behaviors, hinders the progress in this direction.

To evolve the state of the art of current collaborative robots in the manufacturing industry, this project propose the creation of a real-time assessment framework appropriate to the HRC tasks. This expected outcome will support the next step towards collaborative robots capable of understanding and adapting to improve the physical and cognitive ergonomics of human coworkers.

“In the future I hope to become a specialist in the field of ergonomics and to be able to help solve many of the problems that the working population face in their jobs.”



Andry Castro

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iBiogeography: harnessing and measuring the power of big, unstructured data for biogeographical monitoring

Granting Institution: **Institute of Geography and Spatial Planning, University of Lisbon**
Supervisor: **César Capinha** Co-Supervisor: **João Pinto**



The use of 'Big' unstructured data to assess and monitor the distribution of the world's species (i.e., 'iBiogeography') is in its infancy. This project aims to expand this field of research to improve existing knowledge about the geographical patterns and trends of the 'Culicidae' family (i.e., mosquitoes), a taxonomic group of particular concern for disease transmission. To assess this the project will firstly work on the development of a 'deep learning' algorithm that will allow classifying and process (check)lists of species, that are published in high numbers by the scientific literature, each year. Secondly, it will develop and test a Web content mining approach to recurrently searching information items (e.g., images; social media content) evidencing range shifts of problematic species. Finally, it will use the biogeographical knowledge to gather through the two previous tasks, and test how the distribution of culicids has already reshaped their distributions in response to global climate change.

Arturo Sousa

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The Sustainability of Portuguese Cities for Tourism

Granting Institution: **University of Aveiro**
Supervisor: **Susana Teles**



The theme of sustainability of cities is a very current and interdisciplinary topic that leads to a series of interests and influences. Urban sustainability has a clear importance and interest in tourists/visitors, host populations, tourism companies and local/national governments. Tourism, as a type of mobility, leisure, practice, economic, cultural, social phenomenon, can directly and/or indirectly promote the sustainability of cities, therefore, it is proposed to explore and verify the sustainability of portuguese cities for tourism. As national case studies the objective is to present the main cities in Portugal - Porto, Coimbra, Lisbon, Faro, Ponta Delgada and Funchal.

By reading and analysing various national and international sources of information, creating surveys, questionnaires, making specific visits/travels, studying good international practices, it will be possible to present strategies for improving and/or creating greater sustainability in the selected cities.



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Intrusion Detection System Based on Deep Learning Techniques for the Internet of Vehicles in Smart Cities

Granting Institution: **Faculty of Sciences, University of Lisbon**
Supervisor: **Naercio Magaia**



Modern vehicles are capable of sharing information (traffic conditions, entertainment services, and more) between other vehicles on the road. Because of this possibility, there are safety breaches that can put the vehicle and drivers/passengers at risk. This work is focused on developing an intrusion detection system to increase security levels.

“The MIT Portugal Program is a wonderful opportunity to make possible the development of important research in information security solutions by involving industry and academia experts.”



Fernando Ribeiro

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Real time activation of ancillary services in the transmission network: enabling providers from the distribution system using Model Predictive Control

Granting Institution: **Faculty of Engineering, University of Porto**
Supervisor: **João Peças Lopes**



Modern power systems are characterized by an increasing need of Ancillary Services (AS) due to forecasting errors, unpredicted contingencies in the internal system and unforeseen disturbances in neighbouring systems. After decades of independent evolution of transmission and distribution grids, recent research projects have been addressing TSO-DSO cooperation in terms of shared big data platforms of both networks' real-time measurements. In this context, we propose a Model Predictive Control (MPC) for the real-time activation of Ancillary Services supporting the transmission network operation, allowing for the exploitation of resources present on the distribution side. The model is intended for use either post fault or when online security assessment detects an insecurity state, and guarantees that the activation of resources does not violate the distribution grids constraints. The amount of data and model running time are challenges to be addressed through a linearization process. The methodology will be applied using real world data from European networks.



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The city “walking” to 2050. Braga as a Laboratory for a resilient and sustainable system

Granting Institution: School of Architecture, University of Minho
Supervisor: Cidália Silva Co-Supervisors: Cecília Silva, Miguel Bandeira



The Mobility concept, as an objective to achieve the Goals defined for 2050, is the catalyst pretext to explore matters intrinsic to the domain of Architecture. The central research laboratory is Braga. However, in order to incorporate the current best practices in Sustainable Urban Mobility (SUM), five cities have been selected - Bielefeld, Oxford, Pontevedra, Barcelona and Copenhagen - which will serve as a reference to the proposed research strategy. This approach aims to explore the role of Architecture in the paradigm shift in Mobility and to evaluate the level of commitment to the goals set for 2050 and its resilience in the face of calamity situations, such as COVID-19.

The potentialities to combine theory and practice are underlying the methodological principles and imbued with urban acupuncture strategies and projects (SoláMorales, 2008), that have a greater influence on changing social behaviors for SUM and on the replication capacity.

“It was a prestige to be awarded with this scholarship from MIT-Portugal and FCT, due to the international recognition of the quality standards that these agencies confer in terms of scientific, technological and innovation research and the inherent connotation that imbues the merit of the research proposed here.”



Joana Fernandes

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Circular economy of existing building stock: a methodological framework for sustainable refurbishment design

Granting Institution: Instituto Superior Técnico, University of Lisbon
Supervisor: Paulo Ferrão Co-Supervisors: Christoph Reinhart, António Leitão



The lack of standard practices and platforms for assessing refurbishment strategies towards circular economy and its impact in global warming is a challenge for the decarbonisation of existing building stock. Incorporating data and feedback from designers and practitioners since early design stages is important to feed a multi-criteria dynamic process with multiple dimensions, which have to be assessed under a life-cycle perspective. To tackle this issue, a BIM-based “3R Assistant for Sustainable Refurbishment Design” will be developed, including three thematic areas: circularity assessment, material flows assessment and global warming impact. The digital platform will support existing building stock characterization and the design of corresponding refurbishment strategies in a BIM environment, which aim to facilitate standardized practices in construction sector, regarding circular economy in buildings refurbishments, with a positive impact in the mitigation of global warming and the decarbonisation of Portuguese building stock.



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AI Based Market Model for Renewable Energy Communities with Storage Sharing

Granting Institution: Faculty of Engineering, University of Beira Interior

Supervisor: Maria do Rosário Alves Calado



This project proposes an innovative Market Model suited to the concept of a renewable energy community, in which its members can interact through Energy Sharing and share, among themselves, the storage capacity of their stationary batteries or electric vehicles, Storage Sharing. In order to obtain an optimum energy planning for the community, the proposed multi-agent Market Model will be based on Artificial Intelligence (AI), with a hierarchical control structure, which will base their decisions on technical and economic aspects, considering the community load and renewable production forecasts and the restrictions, imposed by each member, for the community participation. To ensure the applicability of the proposed Market Model, a long-range wireless communication module will be developed, based on the Internet of Things (IoT), which will allow the monitoring and control, in real time, of the parameters of each member of the community.



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Preprocessing methods for Supervised Learning and Land Use/Land Cover Classification

Granting Institution: School of Information Management and Data Science, NOVA University of Lisbon

Supervisor: Fernando Bação



Despite the importance of Land Use/Land Cover (LULC) maps to promote sustainability and good resource management, their production continues to be a challenging task. There are various factors that contribute towards the difficulty of generating accurate timely updated LULC maps, both via automatic or photo-interpreted LULC mapping. Data preprocessing, although being a crucial step for any Machine Learning task, is particularly important in the remote sensing domain due to the overwhelming amount of untreated data continuously gathered from multiple remote sensing missions. This PhD project focuses on the challenges found in automatic LULC classification tasks, specifically in data preprocessing tasks: imbalanced learning and anomaly detection problems are addressed as primary aims. Feature extraction and parameter tuning techniques are addressed as secondary/contingency aims.

“The reason for my application lied in my goal of pursuing a career in academia, for both teaching and research activities, particularly within the Machine Learning (ML) and Remote Sensing domains.”



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NeuroStruct: Machine Learning in Structural Design

Granting Institution: Faculty of Engineering, University of Porto

Supervisor: Jorge Américo de Oliveira Pinto Belinha

Co-Supervisors: Sérgio Manuel Oliveira Tavares, Faez Ahmed



Scientific Machine Learning (SML) is a recent trend involving the application of physically or mathematically-informed Machine Learning (ML) techniques to speedup classical numerical computations that are central to many fields of engineering and science. The application of SML techniques to Structural Design (SD) allows designers to explore and assess different solutions quickly, avoiding the need to use traditional Finite Element Models, which, despite being very precise, are computationally expensive and quickly become the bottleneck for experimentation.

This project will contribute to real-time 3D simulations in SD, which will facilitate the exploration of new designs and find optimal solutions without the need to have an expensive computational infrastructure. Furthermore, with this project, we will contribute to the connection of the Mechanical Engineering and ML community. These future cooperations will accelerate the digital transformation in manufacturing.

“I look forward to four years of profound and conscious learning, contact with different entities, from educational institutions to industry, and people with different work methodologies and ways of thinking.”



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InverseESA: Inverse Catalytic Optimization for Sustainable Epoxide Manufacture

Granting Institution: Faculty of Sciences, University of Porto

Supervisor: Maria Natália Dias Soeiro Cordeiro Co-Supervisors: Filipe Carlos Teixeira Gil



This PhD project aims to develop a computational inverse Quantitative Structure Activity Relationship model, to optimize industrial catalytic epoxidation of small alcohols and alkenes. In turn, it will address sustainable manufacturing solutions towards this high economic value chemical reaction. The model aims to target the chemical space by implementing recent data science methodologies, which in turn feed and train machine learning models with data obtained from available experimental results. The project intends to embolden chemists and industries with a predictive model that eases reaction conditions, avoiding high cost quantum mechanics calculations and catalyst design by trial-and-error. It will also allow to find optimal epoxidation catalysts using biomass-based feedstock, thus avoiding the need of raw fossil-fuel commodities. This model will allow to reduce the environmental impact of these industries, lowering waste production, while generating higher product yields.

“With the partnerships made possible by the MIT-Portugal Program, both with academic and industrial institutions, this could be a flagship project that can benchmark a position for Portuguese science in state-of-the-art sustainable chemistry development.”



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ClimateCollab: A collaborative graph for reproducible evidence of climate change

Granting Institution: Faculty of Engineering, University of Porto

Supervisor: João Miguel Rocha da Silva Co-Supervisor: Susana Alexandra Barbosa



This project aims to improve the reproducibility of scientific results in the area of climate change through the construction of an interoperable search engine for sharing evidence of climate change, with a data model based on ontologies and able to link each evidence to the data and algorithms that support it.

As testbed, a collaborative platform will be developed for the representation and retrieval of data sets and the remote execution of associated algorithms. It will use a Linked Data representation to allow the representation of evidences of climate change, georeferenced datasets and algorithms in a single knowledge graph.

The evaluation will be carried out with domain researchers, who will test the retrieval performance when compared to search engines based on metadata indexes and also the computing capabilities of the platform. Actual sensor data from the SAIL project will also be used, combined with other georeferenced data in the area of climate change.

“ By applying to the MPP-FCT Fellowship I saw the opportunity to improve my knowledge and build a tool that would change the way climate change researchers work.”



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Methane biofixation by microalgae/cyanobacteria systems

Granting Institution: School of Engineering, University of Minho

Supervisor: António Augusto Martins de Oliveira Soares Vicente

Co-Supervisors: Maria Madalena dos Santos Alves, Vítor Manuel de Oliveira e Vasconcelos



CO₂ is the most concentrated greenhouse gas (GHG) in the atmosphere and, for this reason, it is the basis of climate policies, leaving other GHGs, such as CH₄, in the background. CH₄ is the second most prevalent GHG emitted by human activities; although its lifetime in the atmosphere is much shorter than CO₂, CH₄ is more efficient on trapping radiation than CO₂, presenting a global warming potential 84-87 times greater over 20 years. Additionally, the methodologies currently employed for CH₄ emissions mitigation, typically physicochemical-based procedures, comprise high-energy requirements and the production/release of CO₂ to the atmosphere. Therefore, this project aims at evaluating the ability of microalgae and cyanobacteria (monocultures and cocultures) to fixate CH₄ (and the resulting CO₂), in order to convert it into biomass and high-value biocompounds for different biotechnological fields.



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Optimization of electric vehicle charging for sustainable energy systems

Granting Institution: Faculty of Sciences and Technology, University of Coimbra
Supervisor: Carlos Henggeler Antunes Co-Supervisor: Marta Lopes



The transportation sector accounts for the world's largest share of the total growth in primary energy consumption. As a promising mobility tool, Electric Vehicles (EVs) are a viable alternative to decarbonize the future transportation system. Although the substantial challenges for power systems are likely to emerge by uncoordinated charging of the wide range of EVs, the coordinated charging (smart charging) strategies are essential to address the problem. The Charging Manager is a coordinator to manage the EV users and power system preferences and requirements; however, these preferences and requirements might be varied and contradicted for the EV users and power system. To tackle the problems, this study aims to exploit the flexibility potential of EVs by developing models and algorithms to support EVs smart charging having into considering the perspectives of EV users (minimizing the charging cost, minimizing the charging time, etc.) and Charging Managers (maximizing the profit and quality of service).

"In the long term perspective, I look forward to (...) find practical solutions in addressing the research questions, impact academia, and adopting them to reshape the sustainable society."



Marcos Motta

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Mobility mining - from individual to group urban mobility patterns

Granting Institution: Instituto Superior Técnico, University of Lisbon
Supervisor: Luiz Guilherme de Picado Santos Co-Supervisors: João Paulo Costeira, Cláudia A. M. Soares



An adequate description of travel demand in an urban area is crucial for mobility management, fostering an efficient urban metabolism. However, to this day, traditional data gathering was unable to effectively provide the needed decision support backed by statistically unbiased evidence for all kinds of trips. This thesis proposal takes a radically new perspective to demand characterization, relating the user's profile to a predictable trip pattern, herein using all big data from Online Social Media (OSM), namely text, images, social links, and geodata. From here, the definition of homophily relationships (clusters) for associated users concerning mobility will allow, much more than usual, adequate characterization of transportation demand within a specific urban area. The ultimate goal is to provide the needed data-backed tools to allow governance to successfully fulfill users' mobility needs, providing conditions to have a better sustainable environment for a city.

"I'm looking forward for the opportunity to be in touch with innovative environment and data science oriented research groups."



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Multiple benefits of energy efficiency policies: Exploring new assessment tools

Granting Institution: Faculty of Sciences and Technology, University of Coimbra

Supervisor: Álvaro Filipe Peixoto Cardoso de Oliveira Gomes

Co-Supervisor: Carla Margarida Saraiva de Oliveira Henrique; Patrícia Pereira da Silva



This work aims to develop a new holistic approach based on the combination of mathematical programming models with Hybrid Input-Output – Life cycle Analysis (HIO-LCA) to help public Decision-Makers (DMs) in the choice and evaluation of energy efficiency (EE) measures that can be supported and adopted in the residential sector, which allows considering the potential economic, energy, environmental, and social impacts, and other benefits generated throughout its lifecycle, promoting a more adequate assessment of measures, potentially contributing to increase their attractiveness. In this study the Portuguese residential sector will be used as case study, however, this approach is ready to be employed to any technology in any country as long as the available supporting data is adapted.

“This fellowship will provide essential help in making my work possible, as well as enabling its success by helping the countries to face the climate emergency without neglecting social concern and fostering its economic development.”



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RNNs for operator occupational risk analysis based on multimodal biosignals

Granting Institution: School of Science and Technology, NOVA University of Lisbon

Supervisor: Hugo Filipe Silveira Gamboa



In the process of digital transformation in Industry – a sector that employs around 25% of active workers in Portugal – there is a need to evaluate workers' well-being, as both musculoskeletal and mental disorders affect a great part of them due to lack of effective methodologies for guaranteeing their occupational health. In the proposed PhD project – integrated in the MIT-Portugal project Operator in a consortium of several acknowledged research groups and corporations – it is aimed to extract, study and understand the occupational factors that affect the well-being of the operator and design solutions to track job quality and prevent risk exposure.

Henceforth, sensors will be used to monitor physiological and motion signals in work context and a software that from the signals assesses risk exposure will be built based on novel deep learning architectures. Finally, the operator will be provided feedback with relevant information, allowing a self-conscious change of conduct.



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Microbiome therapy for improved coral health and reef resilience

Granting Institution: Instituto Superior Técnico, University of Lisbon

Supervisor: Rodrigo Costa Co-Supervisor: Tina Keller-Costa, Raquel Peixoto



The conservation of coral reefs is under unparalleled pressure due to climate change. Coral-microbiome interactions play key roles in coral health in climate change scenarios, but our ability to benefit from such interactions to conserve the reefs' ecological balance is unexplored. This project addresses this pressing demand using unprecedented microbiome manipulation of foundational octocoral species of the genus *Eunicella*. It aims to develop multi-species inoculants of octocoral-associated bacteria and test their effectiveness in boosting coral resilience towards temperature and pathogen pressures. This will be achieved via 1) phenotypic and genotypic screening of octocoral bacterial symbionts for host-beneficial properties; 2) development of multi-species inoculants and in-vivo evaluation of successful host colonization in microcosm experiments; 3) in-vivo determination of the effect of microbiome therapy on host resilience using a high-end mesocosm facility. This project will increase our knowledge of coral-microbiome functioning, while delivering custom methodology useful for future coral reef restoration practices.



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A decision-making tool for the renovation of buildings in Middle East coastal cities under future climate scenarios

Granting Institution: Faculty of Sciences and Technology, University of Coimbra

Supervisor: Adélio R. Gaspar Co-Supervisor: Eugénio Rodrigues



Middle East countries lag in renovating their built environment to counteract the impact of climate change. The main reason for this is the low tax policy on fossil fuels, contributing to global warming and extreme weather events. This project aims to identify clean energy technologies and construction solutions that reduce the buildings' dependence on fossil fuels. The project will analyze the energy, economic, and environmental impacts, which have not yet been assessed comprehensively in this region. As coastal cities are more susceptible to global warming impacts, Bandar Abbas, a coastal city in Iran, is considered a case study. Energy simulations are employed to investigate the performance of a set of reference buildings and determine the most effective measures to cope with this impact under different climate scenarios. A tool will be developed to assist in the decision-making process of planners and architects. The expected outcomes will ultimately influence policymaking in those coastal cities.



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Reducing Ocean Pollution by Upcycling Polyolefin Waste into Value-Added Material

Granting Institution: School of Engineering, University of Minho

Supervisor: Ana Vera Alves Machado Nóbrega Co-Supervisor: Bradley David Olsen



As global polymer production continues to grow, special attention has been given to plastics that end up in oceans threatening the survival of marine lifeforms. Plastic pollution stems from the central role that disposable plastics play in food, medicine, and other industries. Due to the high costs associated with removal of additives from plastic and its incompatibility, only 15% is recycled. The remainder ends up in landfills, incinerated, or released into the environment as pollution. To overcome these limitations, the present project proposes the development of a new upcycling process to transform polyolefin waste into high-value rubber products providing an economic incentive to recapture waste. Functionalization and subsequent crosslinking will be explored, the structural and mechanical properties of the obtained materials will be assessed. This new route for the valorization of plastic waste will contribute to improve the health of our oceans and build a more sustainable planet.

“I have a lot of interest and motivation in conducting research aiming at more ecological and sustainable methods for our planet, so applying for the MPP-FCT PhD Grants seemed the right way to pursue my scientific career.”



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Indoor environment in heritage buildings: monitoring and simulation strategies

Granting Institution: Faculty of Sciences and Technology, University of Coimbra

Supervisor: Adélio R. Gaspar Co-supervisor: José J. Costa



This doctoral research explores monitoring and simulation procedures to identify causes of inappropriate indoor environment conditions, and the respective risks of degradation, and discusses the most appropriate strategies to preserve heritage patrimony. Considering the indoor environment as a set of hygrothermal, lighting conditions, and particulate matter, a review of the evolution of guidelines for collections was made aiming to assess the actual requirements for conservation and identify gaps that deserve improvements and further research. The research englobes continuous and systematic monitoring campaign followed by a correct assessment of the indoor conditions according to literature approaches. Joanina Library is the case study of this project, which is being modeled using appropriate software, EnergyPlus, in regard to the hygrothermal behavior, and Radiance, for the lighting environment. The data from the monitoring campaign is used for the validation of the models. For this purpose, the research methodology will include the study of the indoor environment by recurring monitoring and simulation while assessing the efficacy of passive and management strategies for heritage buildings. In this way, this research will answer the main question regarding there is need to use active systems to control indoor environment in heritage buildings in today's context.

“The present research matches the MIT Portugal propositions and will contribute to the development of solving-problem methods in heritage buildings by monitoring and simulating the indoor environment from a conservation perspective.”

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Digitalization of the footwear industry using artificial intelligence

Granting Institution: School of Engineering, University of Minho

Supervisor: António Gaspar Lopes da Cunha Co-Supervisor: Maria José Ferreira



This research is related to the ongoing Greenshoes 4.0 mobilizer project in which the required computational modelling tools will be developed. The suggested approach in this project will improve the modelling capability, by combining the available codes with AI methods, thus, noticeably minimizing the dependence on the persons involved in the design processes. This approach is mandatory due to the inability to process systematically, efficiently and in a timely manner, the large amount of available information.

“This partnership with the prestigious MIT Portugal Program, surely help the publicity and dissemination of this research outcomes.”

**Paulo Nascimento**

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Using large optimization models to drive additive manufacturing transformation

Granting Institution: Faculty of Sciences and Technology, University of Coimbra

Supervisor: Samuel de Oliveira Moniz Co-supervisor: José J. Costa



Additive manufacturing (AM) technology is a key driver for the digital transformation, as it promises to dramatically change business and innovation models, by shrinking supply chains and altering the global economy. However, findings reveal a lack of research addressing the most prominent trends currently driving AM: such as decentralized production of customized products and small-to-medium volumes transition, thus highlighting the disruptive nature of the expected changes in the industry. Aligned with the MPP2030 funded seed project – Introducing 3D Printing into the Production Chain – the goal of this Ph.D. is to use data-driven techniques and optimization approaches to provide decision-makers with information on how AM techniques will impact processes. The successful accomplishment of this goal will have a positive impact on the automotive, furniture, and semiconductor sectors, by achieving a framework to provide practical guidance on the steps needed to optimize AM processes.

“The network and the knowledge around the MIT Portugal Program will certainly be of great value for me, and I also believe that I can contribute to this community.”



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An integrated multiscale fatigue methodology applied to ocean structural systems

Granting Institution: Faculty of Engineering, University of Porto

Supervisor: José António Fonseca de Oliveira Correia

Co-Supervisors: Abílio Manuel Pinho de Jesus, Grzegorz Stanislaw Lesiuk



Earth is mostly composed of oceans, which are the least explored resources on our planet. The European Council predicts that in 2050, 50% of electricity needs will come from marine renewable energy systems.

In Portugal, the production of marine renewable wind energy started in 2011, with the installation of a 2MW floating wind turbine platform. Recently, in 2020, the first offshore renewable wind farm, Windfloat Atlantic, with a capacity of 25MW, was inaugurated.

In this sense, this Ph.D. research project intends to develop an integrated fatigue methodology applied to support structures for wind towers in an offshore environment, more specifically the fatigue damage assessment based on multi-scale modelling and in full-range fatigue models.

The benefits to the environment are obvious, since the proposed methodology will allow the optimization of design fatigue criteria, contributing to a more responsible renewable energy structural systems generation.

“I expect to improve my ability to solve problems as a scientist and engineer as well as acquire relevant knowledge about the thematic of my work.”



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A new adaptive design approach for active and improved performance pacifiers

Granting Institution: School of Engineering, University of Minho

Supervisor: Cristina Santos Co-Supervisor: Ana Norton



Pacifiers are excellent to calm babies, but there are numerous risks about its prolonged use. The current approaches used to design pacifiers are strongly based on accumulated experience. In a previous work of the candidate, it was shown that realistic computational models allow obtaining concrete data on the effects of pacifiers, opening the route to the digital transformation of the pacifier design and manufacturing methods. The work proposed in this project aims at developing a novel pacifier design methodology together with an innovative adaptive pacifier, both conceived with the support of computational modelling tools. The adaptive pacifier will comprise an intelligent sensing system that will allow monitoring its operation in real-time. Data mining will be applied to identify useful patterns in the collected data, which will be used to parameterize the pacifier usage limits, taking into consideration each user suction pattern, thus allowing continuous pacifier usage supervision.

“For the future, I hope contribute directly to MPP’s 2030 mission in the area of Digital Transformation in Manufacturing, which is also my mission.”



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Feasibility study for the deepwater development of the port of Leixões

Granting Institution: University of Aveiro

Supervisor: Carlos Daniel Borges Coelho Co-Supervisor: Hugo Guedes Lopes



The motivation for the present research plan is to assess the feasibility of a deepwater expansion solution at the port of Leixões, resulting in the first deepwater port terminal in the Portuguese Northwest coast. Regarding the reorganisation recently verified in the waterborne freight transport, there is the corresponding need for adapting sea ports existing infrastructures to later receive largesized cargo vessels. This proposal thereby addresses Portugal's competitiveness through its national port system and intends to establish a key tool in defining intervention priorities, pondering the costs, benefits and impacts of such construction work. The port of Leixões was chosen for the case study as it represents a relevant trade share in the Northwest coast of Portugal and Spain and has potential to broaden its hinterland through the increased capacity of handling containerized cargo.



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Virtus in medium est – History and Planning towards an urban-rural future

Granting Institution: School of Sciences and Humanities, NOVA University of Lisbon

Supervisor: Teresa Marquito Marat-Mendes Co-Supervisor: Veronica Ileana Marin



The future of cities will depend on their formal and functional relationship with nature. Thus, operative concepts are needed for addressing specific realities and challenges, informing integrated strategies for sustainability. This proposal starts from an evolutionary analysis of the concept of "urban-rural space". Three case-studies will serve as reference: Lisbon, Barcelona and Bucharest; studying in each one the historical urban fabric, the planned expansion and the dominant architectural types, as well as their relationship with green spaces (public/private, leisure, agricultural production or environmental preservation). The study of the historical development and genesis of each territory will enable an inventory of solutions suited to their characteristics, which, given their diversity, allow us to think about other cities. This study will result in a monograph, a handbook and an exhibition, aimed at academic and general audiences.



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A supportive, ergonomic and Human-aware framework for Human-Robot collaboration

Granting Institution: School of Engineering, University of Minho
Supervisor: Cristina Manuela Peixoto Santos



This proposal aims at the development of an industrial Human-Robot Collaboration (HRC) framework, within the scope of industry 5.0 and the digital transformation in manufacturing. It intends to address the growing number of Work-Related Musculoskeletal Disorders (WRMSDs), bringing innovation in ergonomic interventions by providing valuable collaborative robot assistance according to the worker needs through the development of human-aware and human-care control strategies, powered by Artificial Intelligence and interoperable wearable technology. Novelty includes bi-directional interaction between human and robot by identifying and monitoring in real-time the worker's motion and fatigue during a collaborative task and tailoring the robot physical-collaboration accordingly. Expected benefits include the operator's well-being, healthier and safer working environments, increased productivity and reduction on the costs derived from WRMSDs, while fostering companies' industrial competitiveness.

"MPP-FCT fellowships are a great opportunity to make Portugal an international reference and at the forefront of scientific and technological innovation."



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The Role and Value of Aggregation of Demand-side Flexibility

Granting Institution: Faculty of Sciences and Technology, University of Coimbra
Supervisor: Carlos Henggeler Antunes Co-Supervisor: Álvaro Gomes



The main research objective is to develop sound and realistic aggregation models based on optimization algorithms for the operation of an aggregator maximizing the utilization of demand-side flexibility while minimizing the prosumer's energy cost and discomfort. The methodological approach consists of developing: mathematical models encompassing the physical behavior of demand-side resources (loads, generation, and storage); algorithms combining mathematical programming and evolutionary computation to deal with hard combinatorial models to optimize prosumers' responsiveness to incentives set by the aggregator; adaptive optimization processes in face of changes occurring in real-time. The main challenge is how to characterize the prosumers' responsiveness and the main novelty of the research is to inset learning capability in the aggregation optimization algorithms. The results can be used by any entity performing the role of aggregation of demand flexibility contributing to optimal power system management.



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Operational forecasting platforms based on morpho-hydrodynamics emulation methods

Granting Institution: **School of Engineering, University of Minho**

Supervisor: **José Luís Pinho** Co-Supervisor: **Isabel Iglesias**



The main objective of this PhD project is to develop a new methodology that will apply data science concepts to implement and configure emulators capable of surrogate high-resolution numerical models, aiming to evaluate the impacts of climate change, extreme events and anthropic intervention in estuarine and coastal zones. These emulators will reduce the computational resources needed for long-term simulations, making it feasible to apply them in operational forecast platforms, which will optimize the decision-making process regarding the adoption of mitigating measures against the impacts of climate change.

“I expect to contribute to the conceptualization of a real-time monitoring and warning system, related to forecasting climate change effects.”

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