

INESC TEC Public Commitment to Transparency and Openness in Science

At INESC TEC, we believe that science and technology only fully achieve their purpose when they serve society.

In this spirit, we are making this document publicly available. It has been prepared based on the application submitted to the 2023/2024 Multiannual Funding Programme for R&D Units of the Portuguese Foundation for Science and Technology (FCT). We do so out of institutional conviction and a commitment to fostering a culture of transparency, responsibility and continuous improvement within the scientific system. We also believe that publicly funded science should be a public good: accessible, understandable and capable of generating collective value.

More than simply disclosing a process, we seek to share a vision. This document reflects our strategic priorities, our choices and our commitment for the 2025-2029 period: to strengthen scientific excellence, promote innovation with economic and social impact, develop talent, deepen international collaboration, and contribute to addressing society's major challenges.

This publication builds upon the transparency practices that INESC TEC already upholds, namely through the public availability of its activity plans, reports and other relevant institutional information. It also represents a coherent step towards making our strategic commitments increasingly explicit and accessible.

It is important to note that this initiative has a specific context. The public disclosure of applications is not common practice in the case of competitive research projects, which often involve sensitive strategic, technical or contractual information. This decision reflects the institutional nature of this application and our conviction that its public availability can generate collective value.

By sharing this content, we also intend it to be useful to others. We want researchers, institutions, decision-makers and citizens to gain a better understanding of our work, draw inspiration from it, learn from it, analyse trends and, should they wish, develop further work based on the information presented here. We believe the scientific system is strengthened when organisational and strategic knowledge is shared more widely.

The document now published is a version initially prepared for internal record and now made public, based on the contents of the submitted application, with a single edit: narrative CVs are not included in this public version. Any references to individual contributions should be understood within the context of a collective effort, reflecting the work of the people who build INESC TEC every day.

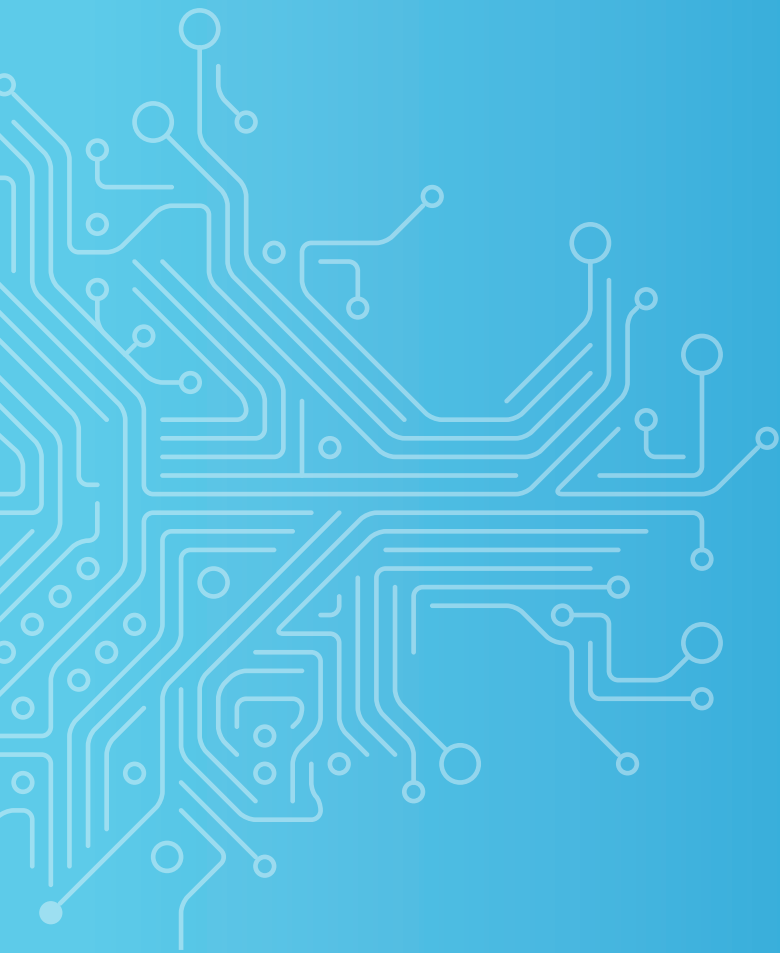
Information related to this process is also available on the dedicated webpage (<https://eval2024.inesctec.pt/>), which will remain active as a complementary access point.

We believe that trust is built through openness, that excellence is strengthened through scrutiny, and that knowledge grows when it is shared.

Above all, this document is an affirmation of that commitment.

INESC TEC

May 2026



INESCTEC

FCT R&D UNITS EVALUATION

2023/2024

Application

INESC TEC

**FCT R&D UNITS EVALUATION 2023/2024
APPLICATION**

Table of Contents

PHASE 1 - REGISTRATION OF THE R&D UNITS 5

 Identification of the R&D Unit 5

 01 Reference..... 5

 02 Coordinator 5

 03 Designation 5

 04 Acronym..... 5

 05 FOS scientific areas 6

 06 Keywords 7

 Involved Institutions 7

 07 Main Management Institution..... 7

 08 Other Management Institutions 8

 09 R&D Unit Contacts 8

 10 R&D Unit website..... 8

 Evaluation Panel 8

 11 Selection of the Evaluation Panel 8

 12 Multidisciplinary Evaluation (Optional) 9

 13 Location for the Evaluation Panel visit to the R&D Unit..... 10

 Laboratory Intensity 11

 14 Laboratory Intensity Levels (High, Medium, Low) 11

PHASE 3 - APPLICATION FORM FOR THE EVALUATION OF R&D UNITS..... 13

 Part 1: Identification of the R&D Unit, Management Institutions, Laboratory Intensity, and Participating Institutions 13

 01 Identification of the R&D Unit 13

 02 Evaluation Panel to which the R&D Unit submits the application..... 13

 03 Laboratory Intensity..... 13

 04 Involved institutions 13

 4.1 Main Management Institution..... 13

 4.2 Other(s) Management Institution(s)..... 13

 4.3 Partnership agreements with other Management Institution(s) 13

 4.4 Participating Institution(s) 13

 4.5 Partnership agreements with Participating Institution(s) (if any) 14

 Part 2: Description of the R&D Unit, main contributions of the team of integrated researchers, External Advisory Board and funding in 2018-2023..... 14

 05 Description of the main contributions of the team of Integrated Researchers in the current application..... 14

5.1 General description of the R&D Unit.....	14
5.2 Identification and brief description of up to 5 contributions that the R&D Unit considers to be the most important during 2018-2023 period.....	15
5.3 Main publications in 2018-2023 by Integrated PhD holder Researchers registered in the application.....	17
5.4 Description of other relevant activities carried out in 2018-2023 by integrated PhD holder researchers registered in the application.....	21
5.5 Explain to what extent the proposed activity plan for the period between 2018-2023 was fulfilled, indicating and justifying any deviations from this plan	23
06 Reports and External Advisory Board Members.....	24
6.1 Reports of the External Advisory Board in 2018-2023	24
6.2 Composition of the current External Advisory Board.....	25
07 Funding during 2018-2023.....	26
08 Integrated PhD holder researchers, PhD students and research contracts in 2018-2023	28
8.1 Integrated PhD holder researchers, PhD students and total research contracts in each year in the period 2018-2023.....	28
8.2 Measures implemented in the development of scientific careers	28
Part 3: Research team with links to CVs and ORCID record.....	29
09 Lists of researchers in the current application	29
9.1 List of Integrated PhD holder Researchers in the R&D Unit.....	29
9.2 List of Collaborating Researchers of the R&D Unit.....	29
9.3 List of PhD students supervised by integrated PhD holder researchers in the R&D Unit	30
Part 4: Activity Plan for 2025-2029.....	30
10 Summary of the Activity Plan for 2025-2029.....	30
10.1 Summary in Portuguese for publication	30
10.2 Summary in English for publicity purposes.....	31
10.3 Summary in English for assessment purposes.....	31
11 Description of the Activity Plan for 2025-2029.....	33
11.1 Objectives and strategy of the R&D Unit for 2025-2029	33
11.2 Organization of the R&D Unit for 2025-2029	36
12 Proposed Research Groups.....	38
12.1 AI - Identification of each Research Group.....	38
12.3 Description and main contributions of each Research Group in 2025-2029.....	39
12.1 BIO - Identification of each Research Group	40
12.3 Description and main contributions of each Research Group in 2025-2029.....	41
12.1 COM - Identification of each Research Group.....	42
12.3 Description and main contributions of each Research Group in 2025-2029.....	43

12.1 CSE - Identification of each Research Group	44
12.3 Description and main contributions of each Research Group in 2025-2029.....	45
12.1 PHT - Identification of each Research Group.....	46
12.3 Description and main contributions of each Research Group in 2025-2029.....	47
12.1 PES - Identification of each Research Group	47
12.3 Description and main contributions of each Research Group in 2025-2029.....	49
12.1 ROB - Identification of each Research Group	49
12.3 Description and main contributions of each Research Group in 2025-2029.....	51
12.1 SEM - Identification of each Research Group.....	51
12.3 Description and main contributions of each Research Group in 2025-2029.....	53
13 Thematic Lines	53
13.1 Digital Models - Identification of each Thematic Line	53
13.2 Description of each Thematic Line	54
13.3 Research Groups that contribute to each Thematic Line	55
13.1 Sustainable Transformation - Identification of each Thematic Line.....	55
13.2 Sustainable Transformation - Description of each Thematic Line.....	55
13.3 Research Groups that contribute to each Thematic Line	56
13.1 Tackling the Extreme - Identification of each Thematic Line.....	56
13.2 Description of each Thematic Line	57
13.3 Research Groups that contribute to each Thematic Line	57
13.1 Trustworthy Technology - Identification of each Thematic Line	58
13.2 Description of each Thematic Line	58
13.3 Research Groups that contribute to each Thematic Line	59
14 Ethical issues.....	59
14.1 Ethical Issues.....	59
15 Aspects of the Activity Plan that involve requesting Programmatic Funding.....	60
16 Funding planned for 2025-2029 for evaluation purposes.	60
16.1 Expected funding of the R&D Unit for 2025-2029.....	61
16.2 Expenditure budget of the R&D Unit at the Main Management Institution.....	63
16.3 Expenditure budget of the R&D Unit in other Management Institutions (if any)	64
16.4 Estimate of the percentage distribution by types of expenditure to be ensured with Base Funding for 2025-2029 that will be obtained following the evaluation	64
17 Budget justification for 2025-2029	64
18 Members of the future External Advisory Board.....	64

ANNEX I – RESEARCHERS FROM EACH RESEARCH GROUP – (RELATED TO PHASE 2 – TEAM REGISTRATION)	66
12.2 AI - Researchers from each Research Group	66
12.2 BIO - Researchers from each Research Group.....	71
12.2 COM - Researchers from each Research Group	73
12.2 CSE - Researchers from each Research Group.....	75
12.2 PHT - Researchers from each Research Group.....	82
12.2 PES - Researchers from each Research Group.....	83
12.2 ROB - Researchers from each Research Group	86
12.2 SEM - Researchers from each Research Group	89

PHASE 1 - REGISTRATION OF THE R&D UNITS

The R&D Registration Form should be filled in Portuguese, except in explicitly identified fields that must also be completed in English.

a. To maintain a R&D Unit

The following reference fields are pre-filled in the Registration Form: designation, name of the coordinator, Main Management Institution and Other Management Institutions (if any) of the R&D Unit. The designation, coordinator name, Main Management Institution and Other Management Institutions fields can be changed.

~~b. To create a new R&D Unit by merging two or more R&D Units~~

~~c. Extinction of a R&D Unit~~

The fields 01-Reference and 02-Coordinator are pre-filled, the last one can be changed. In the form made available to units that selected the option **to maintain**, there are several other fields with prefilled information: x-Designation (in Portuguese), x-Main Management Institution and x-Other Management Institutions.

Identification of the R&D Unit

01 Reference

It is an automatic field, with the code assigned to the R&D Unit.

50014

02 Coordinator

Must be a PhD holder researcher integrated into the R&D Unit affiliated with the Main Management Institution of the R&D Unit (Regulation, paragraph d, number 1, article 3). A researcher can only be coordinator of one R&D Unit.

In the R&D Unit registration form, the name of the coordinator is pre-filled in accordance with the CIÊNCIA ID credentials entered when accessing the application. It is possible to change the coordinator by indicating the CIÊNCIA ID of the new coordinator. After this modification, only the new coordinator can access the R&D Unit registration form.

João Alberto Vieira de Campos Pereira Claro

03 Designation

The name of the R&D Unit must be indicated in Portuguese and English, without using acronyms, each with a maximum of 160 characters. If a R&D Unit is registered and its name coincides with the name of another R&D Unit already registered, an alert will show, and the name of the Unit may be altered.

INESC TEC – Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência

INESC TEC - Institute for Systems and Computer Engineering, Technology and Science

04 Acronym

The acronym for the abbreviation of the name of the R&D Unit must have a maximum of 15 characters. If an R&D Unit registers an acronym that coincides with the acronym of another R&D Unit, an alert will show, allowing changes to be made.

INESC TEC

05 FOS scientific areas

This field is for statistical purposes only and corresponds to the FOS (Field of Science and Technology - classification of scientific areas from the Frascati manual). In this field, **up to 4 scientific areas** must be selected, taking into account the main activities of the R&D Unit.

Engineering and technology – Electrical engineering, Electronics engineering, Information engineering

Exact and Natural sciences – Computer and information sciences

Exact and Natural sciences – Physical sciences

Engineering and technology – Other engineering and technologies

Classification of scientific areas adopted by DGEEC – General Directorate of Education and Science Statistics in accordance with the OECD guidelines.

Domain	Main Scientific Areas of Activity
Exact and Natural sciences	Mathematics
Exact and Natural sciences	Computer and information sciences
Exact and Natural sciences	Physical sciences
Exact and Natural sciences	Chemical sciences
Exact and Natural sciences	Earth and related Environmental sciences
Exact and Natural sciences	Biological sciences
Exact and Natural sciences	Other natural sciences
Engineering and technology	Civil engineering
Engineering and technology	Electrical engineering, Electronic engineering, Information engineering
Engineering and technology	Mechanical engineering
Engineering and technology	Chemical engineering
Engineering and technology	Materials engineering
Engineering and technology	Medical engineering
Engineering and technology	Environmental engineering
Engineering and technology	Environmental biotechnology
Engineering and technology	Industrial biotechnology
Engineering and technology	Nano-technology
Engineering and technology	Other engineering and technologies
Medical and Health sciences	Basic medicine
Medical and Health sciences	Clinical medicine
Medical and Health sciences	Health sciences
Medical and Health sciences	Medical biotechnology
Medical and Health sciences	Other medical sciences
Agricultural sciences	Agriculture, Forestry, and Fisheries
Agricultural sciences	Animal and Dairy science
Agricultural sciences	Veterinary science
Agricultural sciences	Food and agricultural biotechnology
Agricultural sciences	Other agricultural sciences
Social sciences	Psychology

Social sciences	Economics and Business
Social sciences	Educational sciences
Social sciences	Sociology
Social sciences	Law
Social sciences	Political science
Social sciences	Social and economic geography
Social sciences	Media and communications
Social sciences	Other social sciences
Humanities	History and Archaeology
Humanities	Languages and Literature
Humanities	Philosophy, Ethics and Religion
Humanities	Arts (arts, history of arts, performing arts, music)
Humanities	Other humanities

06 Keywords

Fill in 6 keywords in Portuguese and English. They must be chosen in order to characterise the scope of activities of the R&D Unit and must be sufficiently specific to clarify the Unit's main thematic lines or areas of research.

Communications and Photonics

Computer Science an

Artificial Intelligence and Robotics

Bioengineering

d Engineering

Power and Energy Systems

Systems Engineering and Management

PT

Inteligência Artificial e Robótica

Bioengenharia

Comunicações e Fotónica

Ciência e Engenharia de Computadores

Sistemas Eléctricos de Energia

Engenharia de Sistemas e Gestão

Involved Institutions

07 Main Management Institution

The entry in this field of the form should precisely match the legal person identification number (NIPC) and must be chosen from a scroll down menu (facilitated by entering the initial characters of the respective name or NIPC). If the institution is not listed in the form, it is necessary to complete the Pre-registration of Institutions on the PCT. Following this process, the institution should be added to the FCT institutions database. Once validated by FCT, the new institution

will be included in the FCT database within an expected timeframe of two working days. After completing this procedure, it is essential to revisit this field of the registration form, to associate the institution.

If the to maintain option has been selected, the Management Institution field is pre-filled, but can be changed.

INESC TEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência

08 Other Management Institutions

This field must only be filled if there are other Management Institutions in addition to the Main Management Institution. If they exist, they must be indicated analogously to section 07.

If the to maintain option has been selected, the Other Management Institutions field will be pre-filled, but can be changed.

09 R&D Unit Contacts

Postal address, telephone number, email. 10 R&D Unit website: Address (URL) of the home page.

INESC TEC

Campus da FEUP Rua Dr. Roberto Frias

4200 - 465 PORTO

00351 222094000

presidencia@inesctec.pt

10 R&D Unit website

Address (URL) of the home page

www.inesctec.pt

Evaluation Panel

11 Selection of the Evaluation Panel

From the list of Evaluation Panels available on the form, each R&D Unit must **select the Evaluation Panel most appropriate to its scope of activities**

Engineering Sciences and Technologies – Electrical and Computer Engineering

Each R&D Unit chooses from the list below the Evaluation Panel in which it will be evaluated. If less than 5 applications are submitted to an Evaluation Panel, that panel will not operate and the R&D Unit will be assessed by another Evaluation Panel from this list, identified in dialogue with the coordinator of the R&D Unit.

Evaluation Panels UID 2024	
Engineering Sciences and Technologies	Civil and Geological Engineering
Engineering Sciences and Technologies	Computer Sciences and Information Technologies
Engineering Sciences and Technologies	Materials Sciences and Engineering, and Nanotechnology
Engineering Sciences and Technologies	Electrical and Computer Engineering
Engineering Sciences and Technologies	Mechanical Engineering and Engineering systems
Engineering Sciences and Technologies	Chemical and Biological Engineering

Exact Sciences	Physics
Exact Sciences	Mathematics
Exact Sciences	Chemistry
Health Sciences	Biomedicine
Health Sciences	Clinical and Translational Research
Health Sciences	Public Health, Nursing, Health Technologies
Health Sciences	Sport Sciences
Natural Sciences	Agricultural, Agro-food and Veterinary sciences
Natural Sciences	Biological Sciences, Biodiversity and Ecosystems
Natural Sciences	Earth and Environmental Sciences and Technologies
Social Sciences	Language and Communication Sciences
Social Sciences	Educational Sciences
Social Sciences	Law
Social Sciences	Political Sciences
Social Sciences	Economics
Social Sciences	Management
Social Sciences	Psychology
Social Sciences	Sociology, Anthropology and Geography
Arts And Humanities	Architecture and Urbanism
Arts And Humanities	Arts and Design
Arts And Humanities	Literary Studies
Arts And Humanities	History and Archaeology
Arts And Humanities	Philosophy

12 Multidisciplinary Evaluation (Optional)

The R&D Unit must indicate whether it intends a multidisciplinary evaluation. If so, it must select the “Yes” option and **choose a maximum of 2 evaluation panels from the menu.**

YES

Additional panels:

Engineering Sciences and Technologies – Computer Sciences and Information Technologies

Engineering Sciences and Technologies – Mechanical Engineering and Engineering systems

Multidisciplinary Evaluation

In this evaluation exercise, FCT opted for a new multidisciplinary evaluation model, following a bottom-up logic that allows units to be evaluated by committees of readers who integrate specialties from the scientific areas identified by the units. **The reader committees for each unit will be made up of 3 evaluators from the main panel and up to 2 additional evaluators from the scientific areas of the other panels selected in point 12.** These evaluators will act, for that unit, as full panel members, therefore integrating the committee of readers who will prepare a detailed evaluation proposal for the evaluation panel, participating in all phases of the evaluation process, including visiting the units

whenever possible, as well as the discussion meeting and plenary decisions of the panel. Therefore, as a result of the choice made, the units may constitute multiple multidisciplinary evaluation configurations. This is an optional field and it should be noted that the multidisciplinary evaluation will not result in any advantage or bonus for the R&D Unit in its evaluation process.

Evaluation Panels UID 2024	
Engineering Sciences and Technologies	Civil and Geological Engineering
Engineering Sciences and Technologies	Computer Sciences and Information Technologies
Engineering Sciences and Technologies	Materials Sciences and Engineering, and Nanotechnology
Engineering Sciences and Technologies	Electrical and Computer Engineering
Engineering Sciences and Technologies	Mechanical Engineering and Engineering systems
Engineering Sciences and Technologies	Chemical and Biological Engineering
Exact Sciences	Physics
Exact Sciences	Mathematics
Exact Sciences	Chemistry
Health Sciences	Biomedicine
Health Sciences	Clinical and Translational Research
Health Sciences	Public Health, Nursing, Health Technologies
Health Sciences	Sport Sciences
Natural Sciences	Agricultural, Agro-food and Veterinary sciences
Natural Sciences	Biological Sciences, Biodiversity and Ecosystems
Natural Sciences	Earth and Environmental Sciences and Technologies
Social Sciences	Language and Communication Sciences
Social Sciences	Educational Sciences
Social Sciences	Law
Social Sciences	Political Sciences
Social Sciences	Economics
Social Sciences	Management
Social Sciences	Psychology
Social Sciences	Sociology, Anthropology and Geography
Arts And Humanities	Architecture and Urbanism
Arts And Humanities	Arts and Design
Arts And Humanities	Literary Studies
Arts And Humanities	History and Archaeology
Arts And Humanities	Philosophy

13 Location for the Evaluation Panel visit to the R&D Unit

The evaluation of the R&D Unit includes the visit of Panel members to the Unit. In this field, **the address of the site to visit must be indicated**. In the case of R&D Units with more than one hub, the address of the hub to be visited should be indicated.

INESC TEC

Campus da FEUP Rua Dr. Roberto Frias
4200 - 465 PORTO

Laboratory Intensity

14 Laboratory Intensity Levels (High, Medium, Low)

If medium or high are selected, identify the elements that justify the level of laboratory intensity according to the description. The justification should also clearly state how facilities or infrastructures contribute and are aligned with the research goals and needs of the research unit, as well as demonstrating their relevance regarding the outputs produced and the mission of the unit.

The laboratory intensity level will be validated by the evaluation panels and will be considered for the base funding attributed to the research unit.

Maximum 4000 characters.

LABORATORY INTENSITY LEVELS	LEVEL DESCRIPTION
High [f=1,2]*	R&D unit with equipments and/or laboratories, or that participates in campaigns and/or field activities, that have significant operating and maintenance costs, in relation to the base funding of R&D unit.
Medium [f=1,1]	R&D unit with archives, libraries or platforms for public use, database infrastructures of national and European value and other equipment and laboratories not falling within the previous “high” definition.
Low [f=1,0]	R&D unit lacking significant levels of the aforementioned elements.

*f is the multiplicative factor to be applied in the base funding.

Laboratory Intensity Level: HIGH

INESC TEC R&D is anchored in advanced research infrastructures, critical for its mission across key domains like bioengineering, communications, optics, power and energy, and robotics. On average, this equipment and research infrastructures have significant operational and maintenance costs exceeding 3.5% of the unit’s overall budget, corresponding to an equivalent of 60% of its base funding. This currently translates into 18 dedicated staff, demonstrating INESC TEC’s commitment to providing the national research community with experimental means to carry out excellent and impactful science.

In robotics, communications, and energy, INESC TEC regularly conducts cutting-edge field experiments, many of them in remote and hostile environments (deep sea, arctic waters, flooded mine, islanded electrical systems), requiring large teams and heavy and complex support equipment.

Key infrastructures and contributions:

Smart Grids and EV Lab: Equipped with a versatile microgrid capable of operating in isolated mode and real-time simulation capabilities, it enables power converter development for high-end applications and dynamic equivalents for active distribution networks and smart power transformers.

TEC4SEA: A comprehensive marine research facility with vessels, crucial for advanced marine systems studies, such as navigation and control algorithms for marine robots and validation of underwater acoustic localisation algorithms.

Field robotics labs: Host diverse robotics platforms (underwater, surface, ground and aerial) equipped with perception, navigation, and actuation systems. Support to simultaneous navigation and mapping approach with reduced memory requirements for precise agriculture scenarios and algorithms for maritime surveillance using hyperspectral imaging.

Industry and Innovation Lab: Houses collaborative robotics, such as mobile platforms, flexible automated production cells, manipulators, and underlying infrastructure, enhancing assembly processes and workplace safety.

Communications Lab: With optical and electronic test equipment, anechoic chamber for antenna characterisation, and field-going equipment, it contributes to traffic and energy-aware placement algorithms for slicing-aware aerial networks and electronics control architecture for sub-THz intelligent surfaces based on memristors.

Microfabrication and photonics Lab: With a femtosecond laser direct writing lab, a class 1000/10000 cleanroom, among other assets, it contributes to world record levels of sensing resolution and sensitivities using Vernier effects and multi-modal spectral imaging and observation of two-dimensional quantum turbulence regimes, including the first evidence of its characteristic energy power laws.

Neuro-Engineering Lab: Part of the ESFRI EBRAINS, with a f-MRI simulator equipped with 64ch video-EEG medical systems and a neurophotonics micro&nano sensing workbench, contributing to 3D video-EEG for epilepsy seizures diagnosis and deep learning for near-real-time pathological motion detection in clinical neurology.

Computing infrastructures: With over 150 shared server-oriented computing nodes, encompassing about 200 CPUs and 60 GPUs, this highly performant and efficient processing infrastructure is instrumental in every research topic.

The use of these facilities aligns with the European Charter of Access principles, ensuring a diverse range of research activities from excellence-driven academic research to market-driven innovation. This approach enhances INESC TEC's role in significant European collaborations and projects.

INESC TEC infrastructure underpins innovative research and attracts top-tier talent for MSc and PhD programs, critical for advancing scientific knowledge. The labs have been instrumental in developing technologies that align with INESC TEC's strategic goals. They have significantly contributed to establishing strategic partnerships and promoting its international recognition and research output.

PHASE 3 - APPLICATION FORM FOR THE EVALUATION OF R&D UNITS

The application form is organized into 4 parts and 18 sections:

Part 1: Identification of the R&D Unit, Management Institutions, Laboratory Intensity, and Participating Institutions

All information in this section is pre-filled with data from the R&D Unit registry and cannot be changed, **except section 04 – Involved Institutions**

01 Identification of the R&D Unit

02 Evaluation Panel to which the R&D Unit submits the application

03 Laboratory Intensity

04 Involved institutions

The Main Management Institution and the other Management Institutions of the R&D Unit are automatically identified in this section based on the information entered in the R&D Unit registration form:

4.1 Main Management Institution

Pre-filled field from the R&D Unit registration

INESC TEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência

4.2 Other(s) Management Institution(s)

Pre-filled fields from the R&D Unit registration

–

4.3 Partnership agreements with other Management Institution(s) (if there is one other than the main Management Institution)

For each Management Institution other than the Main Management Institution, upload the respective Partnership Agreement with the Management Institution, after filling out the template provided in Annex IV of this Guide, duly signed.

–

4.4 Participating Institution(s)

To be selected from the list of institutions registered in the FCT's database and available in this field.

C.E.P.- COOPERATIVA DE ENSINO POLITÉCNICO CRL (CEP)
Cooperativa de Ensino Superior de Serviço Social, CRL (CESSS)
Faculdade de Ciências da Nutrição e Alimentação (FCNA/UP)
Faculdade de Ciências da Universidade do Porto (FCUP/UP)
Faculdade de Economia da Universidade do Porto (FEP/UP)
Faculdade de Engenharia da Universidade do Porto (FE/UP)
Instituto Politécnico de Leiria (IPLeiria)
Instituto Politécnico do Cávado e do Ave (IPCA)
Instituto Politécnico do Porto (IPP)
Instituto Superior de Engenharia do Porto (ISEP/IPP)
Universidade Aberta (Uab)
Universidade da Beira Interior (UBI)

Universidade da Madeira (UMA)
Universidade de Coimbra (UC)
Universidade de Trás-os-Montes e Alto Douro (UTAD)
Universidade do Minho (UM)
Universidade Fernando Pessoa (UFP)

4.5 Partnership agreements with Participating Institution(s) (if any)

For each Participating Institution, upload the respective Partnership Agreement, after filling out the template provided in Annex V of this Guide, duly signed.

Agreements uploaded

Part 2: Description of the R&D Unit, main contributions of the team of integrated researchers, External Advisory Board and funding in 2018-2023

05 Description of the main contributions of the team of Integrated Researchers in the current application

5.1 General description of the R&D Unit

For the period between January 1, 2018 and December 31, 2023, describe the R&D Unit's, objectives, activities carried out, results obtained, and internal organization. If the R&D Unit did not exist, fill in the areas of activity and results obtained by Integrated PhD holder Researchers registered in the application (**do not list publications here**).

Maximum 4 000 characters.

INESC TEC is a private, non-profit association with Public Interest status dedicated to scientific research and technological development, technology transfer, advanced consulting and training, and the pre-incubation of new academic spin-offs.

The University of Porto, INESC, the Polytechnic Institute of Porto, the University of Minho, and the University of Trás-os-Montes e Alto Douro are INESC TEC's associates. INESC TEC is headquartered in Porto and where it has three sites, plus the Braga and Vila Real sites.

As a free-thinking and diverse community, INESC TEC's mission is to take on bold science, technology, and innovation challenges, empowering talent, collaborative ecosystems, and public policies that make a difference in our economy and society. The excellence of INESC TEC in pursuing its mission is officially recognised by the FCT with the title of Associate Laboratory (LA) and by the Ministry of Economy as a Technology and Innovation Centre (CTI).

Additional information regarding the profile of INESC TEC can be accessed at: <https://eval2024.inesctec.pt/>

During 2018–2023, INESC TEC aimed to excel in research and seek its social and economic impact, with a unifying commitment to the scientific and technological aspiration of fostering pervasive intelligence. To this end, INESC TEC prioritised rigorous and responsible research, talent development, full coverage of the knowledge value chain, and international visibility and presence.

With an average of 350 R&D projects per year from 2018 to 2023, INESC TEC carried out research at all Technology Readiness Levels (TRL), providing bidirectional pathways between scientific contributions and technological innovations in response to market and societal needs. Besides the drive for impactful contributions, its research activities are characterised by their interdisciplinarity and strong commitment to serve the academic, research and innovation communities.

During the reporting period, INESC TEC's science management model transitioned to a more comprehensive and inclusive approach, focusing on the dynamics and multidisciplinary nature of its Research Centres and individual researchers. The introduction of eight Scientific Domains was intended to enhance scientific cohesion and facilitate communication with communities outside of INESC TEC. Each Scientific Domain connects researchers according to their scientific expertise and contributions and identifies the institution's competencies within that field. Scientific Domains

thus became forums for discussing and planning INESC TEC's research trajectory and platforms for strategising on short to medium-term goals leading to quantifiable results.

Results

INESC TEC met, and often exceeded, its growth objectives and impact, summarised across the following six dimensions:

- Human resources: The number of R&D employees with non-term contracts has more than doubled, a clear indicator of the capacity of the institution to attract and retain talent.
- Funding: Maintaining diversified sources, funding increased by 170% with an emphasis on innovation activities, that represent the added value to society of the developed research.
- Scientific publication: The number of articles in indexed journals and conferences has steadily increased by more than 20%, with a renewed emphasis on high-quality venues.
- Students: Continued efforts to attract younger talent resulted in a 16% increase in PhD supervision, with a strong investment in supporting tuition fees to grant holders.
- Scientific dissemination: Despite the constraints imposed by COVID-19, researchers maintained an impressive level of scientific service and dissemination initiatives such as journal editorship (600) and international symposium leadership (+1600).
- IP valorisation: A sustainable IP valorisation strategy tripled invention disclosures and maintained the number of patent applications while diversifying and internationalising them.

5.2 Identification and brief description of up to 5 contributions that the R&D Unit considers to be the most important during 2018-2023 period

From Integrated PhD holder Researchers registered in the current application, independently of the R&D Unit having previously existed or not.

For the period between January 1, 2018 and December 31, 2023, describe the contributions of integrated PhD holder researchers registered in the R&D Unit's application (regardless of whether it previously existed or not) considered to be the most relevant. Concerning contributions that are publications, do not just cite the publication, but synthetically describe the contribution and justify why it is considered relevant.

Maximum 10 000 characters.

1) Decentralised Privacy-Preserving Proximity Tracing

Early in the COVID-19 pandemic shutdown, research teams at INESCTEC brainstormed online to determine how their research could be beneficial. Specifically, we aimed to merge our prior expertise in security and privacy with gossip-based dissemination and aggregation for collaborative exposure notification. We teamed up with nine teams from top research institutions in seven European countries in the DP3T project led by Carmela Troncoso at the EPFL, leading to the co-authorship of the seminal DP3T paper [10.48550/arXiv.2005.12273] which has been recognised as extraordinary in how the proposed algorithm reconciled privacy with efficacy [en.wikipedia.org/wiki/Decentralized_Privacy-Preserving_Proximity_Tracing].

The next few months were a long struggle. First, against the siren song of non-privacy-preserving proposals. Then, to make DP3T work in practice, which was solved after Google and Apple adopted the core principles of DP3T in GAEN and added their vast resources to development and testing. Lastly, the team worked on designing and launching Stayaway COVID, the exposure notification system adopted by the government in Portugal, ensuring its timely deployment for practical use [10.1145/3524107]. Specifically, the team at INESCTEC managed the technical architecture and implementation of the frontend and backend systems, integrating them with the National Health Service IT systems. Additionally, we engaged in the European Commission-led initiative to support EU-wide roaming services. In the end, Stayaway COVID was installed on more than three million downloads and ensured five-nines availability until the evolution of the virus, knowledge of the disease, and vaccines showed that exposure notification was no longer needed.

According to a study in Nature, exposure notification systems, including Stayaway COVID, played a significant role in influencing the course of the COVID-19 pandemic and contributing to saving lives [10.1038/d41586-023-02130-6].

2) Contribute towards improved management and information exchange between transmission system operators (TSO) and distribution system operators (DSO) while enabling the integration of distributed energy resources (DER) flexibility

A seminal concept of flexibility areas was proposed [10.1109/TPWRS.2018.2805765] and later refined [10.1109/TPWRS.2022.3214106] to address multiple TSO-DSO interconnections using data-driven network equivalents. This concept inspired research groups like LIST [10.1109/TPWRS.2023.3328156] and the Univ. of Melbourne [10.1109/TSG.2022.3188927]. Grey-box dynamic models were also proposed [10.1016/j.epsr.2019.106006], contributing to improving transmission system frequency and voltage stability analysis while preserving sensitive information about the network and its clients. It emulates the aggregated behaviour of a heterogeneous set of DER connected to the distribution grid. These developments were demonstrated in EU projects TDX-ASSIST and EU-SysFlex, engaging EU TSO and DSO and successfully showcasing coordinated operational planning of the two systems via the computation of flexibility maps in real-world meshed grids.

Stochastic algorithms were proposed to help the DSO follow the agreed-upon reactive power at the TSO-DSO interconnections [10.1016/j.segan.2020.100333] by procuring local flexibility from DER while minimising the impact of RE forecast uncertainty. Contribution towards effective and standardised flexibility procurement via DSO-oriented services [10.3390/en14154451], avoiding sharing sensitive network data. A grid segmentation strategy was proposed, aggregating DER that can effectively solve grid constraints [10.1109/EEM54602.2022.9920997] and ensure that flexibility activation does not cause additional constraints, improving coordination. Integrated with DSO (E-REDES) and market clearing platforms (N-SIDE), these algorithms were validated in real distribution networks in the EUuniversal project [10.1049/icp.2022.0881].

3) Pioneering algorithms for UAV-assisted wireless networks

The contribution focused on developing and implementing novel algorithms for aerial networks, with a significant advance in enhancing network performance, efficiency, and adaptability. This work encompasses innovative solutions in position control, routing, and active queue management [10.1016/j.adhoc.2021.102525; 10.1016/j.adhoc.2022.103000], specifically tailored for aerial communication networks. These algorithms are designed to address critical challenges in network management, including optimising throughput, minimising delay, ensuring efficient resource allocation, and enhancing overall network reliability and responsiveness. The advancements achieved through these contributions not only surpassed existing state-of-the-art methodologies in terms of performance gains but also introduced a new paradigm in the design and operation of aerial networks.

At the heart of these advancements are the position control and routing algorithms for aerial networks, which have proven to significantly outperform their counterparts by ensuring higher throughput and lower delay. These algorithms optimise the dynamic positioning and movement of aerial platforms to maintain optimal network connectivity and performance, namely in extreme environments [10.1109/ACCESS.2020.2971487]. Similarly, the placement and active queue management algorithms further enhance these networks by intelligently managing network traffic flows and resources, ensuring that performance gains are maximised without compromising on efficiency and reliability.

The development of traffic-aware and traffic- and energy-aware placement algorithms [10.1109/ACCESS.2022.3168695] marked a noteworthy innovation in the management of aerial networks. These algorithms consider both the current network load and traffic patterns and energy efficiency in the decision-making process, which is particularly crucial for the sustainability of aerial networks. In this way, they enable significant gains in network performance and ensure these gains are achieved with optimal resource utilisation and minimal environmental impact.

4) Strategic Inventory and Pricing Models for Omnichannel Retail Optimisation

Omnichannel retailing, integrating online and offline sales channels, has emerged as the most significant research area in retail operations. Our work has been pivotal in advancing the field since 2015, developing cutting-edge empirical and

analytical models to understand supplier/customer behaviour and endogenise it into inventory and pricing decision analytical models for omnichannel retailers, while acknowledging the complexities of retail planning in the digital era.

In collaboration with industry leaders such as Sonae (grocery) and Farfetch (fashion), two of our studies [10.1287/msom.2022.1124; 10.1287/msom.2022.1105] have introduced innovative, counterintuitive policies that resulted in new theories and practical impact. The first study changed retailers' approach to reserving stock to serve customers, and the second resulted in a redesign of incentives between marketplaces and suppliers.

Our studies, lauded for their analytical rigour matching practical insights from empirical methods, have been published in prestigious journals (Manag. Sci., Manuf. Serv. Oper. Manag., MIT Sloan Manag. Rev.) and are frequently cited by the academic (e.g., Prod. Oper. Manag.) and practitioner (e.g., McKinsey Quarterly) communities.

Retailers adopting our strategies have reported enhanced decision-making capabilities, improved fill rates, shorter product time-to-market, and greater profitability. Seminars by our team at MIT Sloan Manag. Rev. exemplify the influence of our research.

We have extended our first study to the management of perishable products. The Be Fresh project (2022-2024), aligned with hunger and sustainable consumption SDGs, aims to reduce food waste by optimising discount and production planning across the food value chain, based on customer reaction to the evolution of shelf-life. Initial results obtained with a discrete choice model embedded in a proximal policy optimisation algorithm indicate an opportunity to reduce waste by more than 20% compared to state-of-the-art policies.

5) Novel experimental platforms for Quantum Analogue Simulation and Optical computing

When combined with wavefront shaping techniques, light propagation in nonlinear media offers a unique playground for the deployment of analogue quantum simulators as it features an interplay of coherent wave-like interferometric effects and nonlinear particle-like dynamics. During the period of evaluation, the team at INESC TEC has extensively explored the propagation of light inside a nonlinear photorefractive crystal and its mathematical isomorphism to serve as an experimental model for a two-dimensional quantum-fluid (in particular, a Bose-Einstein Condensate). Special emphasis goes to achievements in the observation of characteristic signatures of 2D quantum-like turbulence regimes [10.1088/1367-2630/aca49a] as well as high-profile collaborations in the development of physical analogues for alternative models of gravity [10.1103/PhysRevD.103.124019]. Finally, leveraging on its unique versatility, these platforms have been studied for all-optical computing applications, demonstrating capabilities of light-speed processing of data in the optical domain by exploiting strong nonlinear dynamics that enable neuromorphic architectures in the form of optical reservoir computers and extreme learning machines, such as the one reported in [10.1103/PhysRevD.103.124019].

5.3 Main publications in 2018-2023 by Integrated PhD holder Researchers registered in the application

For the period between January 1, 2018 and December 31, 2023, a selected set of the most relevant publications, authored by integrated PhD holder researchers should be made **available online through an URL specific addresses with the full texts in PDF format**. The maximum number of selected publications is defined in the following table:

Integrated PhD holder Researchers	Maximum number of publications to be made available
<20	5
≥20 and <40	10
≥40 and <80	15
≥80 and ≤160	20
>160	25

The selected publications will be analysed in detail by the evaluation panels, meaning that they must be **chosen based on the quality, merit, relevance, and representativeness of the scientific activity carried out by the R&D Unit.** Therefore, they should **not be selected based on any bibliometric indicator** but rather in accordance with the framework of the Coalition for Advancing Research Assessment (CoARA) principles and commitments, namely assessing the content and not the publication venue, format or language.¹

Please note that each link indicated must correspond only to the PDF file of a given publication.

1. A.D. Gomes, B. Hartmut Bartelt & Orlando Frazão, "Optical Vernier Effect: Recent Advances and Developments," *Laser & Photonics Reviews* 15, no.7, 2021, doi: 10.1002/lpor.202000588.
<https://onlinelibrary.wiley.com/doi/epdf/10.1002/lpor.202000588>
2. A.G. Ramos, E. Silva & J.F. Oliveira, "A new Load Balance Methodology for Container Loading Problem Road Transportation," *European Journal of Operational Research* 266, no. 3, 2018, doi: 10.1016/j.ejor.2017.10.050.
<https://zenodo.org/records/10980591>
3. C. Gonçalves, R.J. Bessa & P. Pinson, "Privacy-preserving distributed learning for renewable energy forecasting," *IEEE Transactions on Sustainable Energy* 12, no. 3, 2021, doi: 10.1109/TSTE.2021.3065117.
<https://zenodo.org/records/4588854>
4. C.L.E. Franzke, S. Barbosa, R. Blender, H.B. Fredriksen, T. Laepple, F. Lambert, T. Nilsen, K. Rypdal, M. Rypdal, M.G. Scotto, S. Vannitsem, N. Watkins, L. Yang & N. Yuan, "The structure of climate variability across scales," *Reviews of Geophysics* 58, 2020, doi:10.1029/2019RG000657.
<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2019RG000657>
5. D. Amalfitano, A.C.R. Paiva, A. Inquel, L. Pinto, A.R. Fasolino & R. Just, "How do Java Mutation Tools Differ?," *Communications of the ACM* 65, 2022, doi: 10.1145/3526099.
<https://dl.acm.org/doi/pdf/10.1145/3526099>
6. E. Costa, A.L. Soares & J.P. de Sousa, "Industrial business associations improving the internationalisation of SMEs with digital platforms: A design science research approach," *International Journal of Information Management* 53, 2020, doi:10.1016/j.ijinfomgt.2020.
<https://zenodo.org/records/10961037>
7. E.N. Almeida, H. Fontes, R. Campos, & M. Ricardo, "Position-Based Machine Learning Propagation Loss Model Enabling Fast Digital Twins of Wireless Networks in ns-3," *Proceedings of the 2023 Workshop on ns-3 (WNS3 '23)*. Association for Computing Machinery, 2023, doi:10.1145/3592149.3592150.
<https://zenodo.org/records/10970167>
8. G. Sampaio, R. Bessa, C. Gonçalves & C. Gouveia, "Conditional Parametric Model for Sensitivity Factors in LV Grids: A Privacy-Preserving Approach," *Electric Power Systems Research* 211, 2022, doi:10.1016/j.epsr.2022.108316.
<https://pscc-central.epfl.ch/repo/papers/2022/12840.pdf>

¹ Please refer to CoARA's Core Commitments, namely, commitment 3, available [here](#).

APNDYGkE7kreFCO8p1th4KNI0Mcko4QVLCe6myKe5tdn%2FmXabSiq0%2FHPdSIR6wnuUdqT9YWzk7xXr%2FWI8TVWgcjWvxnoWuSBricOk6njQsfyAVi6dY%2Fg%2B6vB4ehmy9%2F9FN4Q4H42XiaTLWnh9hdv%2Ffv97Zo1%2BYfjKcEib74DETDaJW%2F%2B0xPcEal6qXroFeTMIgeipxJTDg88t4oY1hVbLJVvCf7cuPfw2mOAhflyQOX8Qly2Ks%2Fpon03uWuYAc%2BjZuNPuVrmi5rVDqi%2FRAQMik1I7mw%2FSbrClLoH%2FfyprzZm%2Fd8ZUTwbwVfmSkkPo8JZqKt4575NAACJu2rufptphnXXPBvOuBlzynAHO1QDI%2FoWdk3hD33vip3vhFTklolZddHgsK9DI6fn5AVc%2F2gfv1kthi3kDyNReu6msVtk%2Fr%2B3gNQSbrTyZjPH%2FHATSG6BsLgCSN0wVtI2b1kyph%2B%2B3Vum3gicMw1un%2BsAY6sQHVf40%2B7bCqAZ0MxStu%2FiaUTdigqHildXsFAwbdILCboUBuyNDvJPNaouryRghONug%2BJL7zq%2FUEQ7gNAMaSSlY9KZdRkKbX6xj15cpXXVtKcsoCiw1I9uxTd%2B035VttKDiT4giWHxtyCDUNo1aN%2B16PzbvXahjGhMhWhhFZBXXPwJZQvYRSNIcmdjVPzfkXFv%2BcAqe4XL54tWtlla2UiaX3A2InlJlCfxTLUia3niEWSjo%3D&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Date=20240417T122137Z&X-Amz-SignedHeaders=host&X-Amz-Expires=300&X-Amz-Credential=ASIAQ3PHCVTYSVC2TDMJ%2F20240417%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Signature=9d048993c9e69ecf6a8b450f5f9071b857e01e9e5f8b88e5af20e108a2e92703&hash=1857d8b1adc0d53e4e04ee2afd8a52daa268c2f158cfb7add2b853835d290099&host=68042c943591013ac2b2430a89b270f6af2c76d8dfd086a07176afe7c76c2c61&pii=S0923474823000310&tid=spdf-4056c97f-60e3-4164-8ce8-1243227ffa54&sid=8bdedd4d2deb7040fd18289-04714e468b55gxrbq&type=client&tsoh=d3d3LnNjaWVvY2VkaXJlY3QuY29t&ua=0a125d515201515e5704&rr=875c603d9e1448a7&cc=pt

15. J.M. Maia, V.A. Amorim, D. Viveiros & P.V.S. Marques, "Femtosecond laser micromachining of an optofluidics-based monolithic whispering-gallery mode resonator coupled to a suspended waveguide," *Scientific Reports* 11, 2021, doi: 10.1038/s41598-021-88682-x.

<https://www.nature.com/articles/s41598-021-88682-x.pdf>

16. J.P.C. de Souza, L.F. Rocha, J.B. Cunha & A.P. Moreira, "Robotic grasping: from wrench space heuristics to deep learning policies," *Robotics and Computer-Integrated Manufacturing* 71, 2021, doi: 10.1016/j.rcim.2021.102176.

<https://zenodo.org/records/10980660>

17. J.S. Paiva, P.A.S. Jorge, R.S.R. Ribeiro, M. Balmanã, D. Campos, S. Mereiter, C. Jin, N. Karlsson, P. Sampaio, C.A. Reis & J.P.S. Cunha, "iLoF: An intelligent Lab on Fiber Approach for Human Cancer Single-Cell Type Identification," *Scientific Reports* 10, 2020, doi:10.1038/s41598-020-59661-5.

<https://www.nature.com/articles/s41598-020-59661-5.pdf>

18. M. Barbosa, G. Barthe, X. Fan, B. Grégoire, S.H. Hung, J. Katz, P.Y. Strub, X.Wu & L. Zhou, "EasyPQC: Verifying Post-Quantum Cryptography," *Proceedings of the 2021 ACM SIGSAC Conference on Computer and Communications Security*, 2021, doi: 10.1145/3460120.3484567.

<https://eprint.iacr.org/2021/1253.pdf>

19. M. Couto, J.A. Peças Lopes & C.L. Moreira, "Control strategies for multi-Microgrids islanding operation through Smart Transformers," *Electric Power Systems Research* 174, 2019, doi:10.1016/j.epr.2019105866.

<https://zenodo.org/records/10980850>

20. P. Fortuna & S. Nunes, "A Survey on Automatic Detection of Hate Speech in Text," *ACM Computing Surveys* 51, no. 4, 2018, doi:10.1145/3232676.

<https://zenodo.org/records/10970234>

21. P. Pinto, J. Bispo, J.M.P. Cardoso, J.G. Barbosa, D. Gadioli, G. Palermo, J. Martinovic, M. Golasowski, K. Slaninova, R. Cmar, R. & C. Silvano, "Pegasus: Performance Engineering for Software Applications Targeting HPC Systems," *IEEE Transactions on Software Engineering* 48, no. 3, 2022, doi: 10.1109/TSE.2020.3001257.

<https://zenodo.org/records/10970256>

22. R. Campos, V. Mangaravite, A. Pasquali, A. Jorge, C. Nunes & A. Jatowt, "YAKE! Keyword Extraction from Single Documents using Multiple Local Features," *Information Sciences* 509, 2020, doi:10.1016/j.ins.2019.09.013.

<https://zenodo.org/records/10971108>

23. R. Macedo, M. Miranda, Y. Tanimura, J. Haga, A. Ruhela, S. L. Harrell, R. T. Evans, J. Pereira & J. Paulo, "PADLL: Taming Metadata-intensive HPC Jobs Through Dynamic, Application-agnostic QoS Control," *2023 IEEE/ACM*

23rd International Symposium on Cluster, Cloud and Internet Computing (CCGrid), 2023, doi: 10.1109/CCGrid57682.2023.00015.

<https://zenodo.org/records/10980382>

24. R. Mendes, A. Brandão, J.P. Vilela & A.R. Beresford, “Effect of User Expectation on Mobile App Privacy: A Field Study,” International Conference on Pervasive Computing and Communications (PerCom), 2022, doi: 10.1109/PerCom53586.2022.9762379.

<https://zenodo.org/records/10971142>

25. S. Barbosa, N. Dias, C. Almeida, G. Silva, A. Ferreira, A. Camilo & E. Silva, “Precipitation-Driven Gamma Radiation Enhancement Over the Atlantic Ocean,” Journal of Geophysical Research: Atmospheres, 2023, doi: 10.1029/2022JD037570.

<https://zenodo.org/records/10980976>

5.4 Description of other relevant activities carried out in 2018-2023 by integrated PhD holder researchers registered in the application

(do not include publications or contributions indicated in 5.2 and 5.3)

For the period between January 1, 2018 and December 31, 2023, describe other relevant activities, carried out by integrated PhD holder researchers registered in the application (regardless of whether the R&D Unit previously existed or not), namely: international collaboration; evidence of proactivity in seeking co-financing (applications to other sources of funding, including, for example, European Projects, ERC and Marie Curie grants, Regional Programs, if applicable, Programs from other funding agencies, etc.); advanced training in the unit and in collaboration with other national and international Institutions; scientific training of young students; organization of conferences, colloquia or seminars; patents, prototypes or products; transfer of knowledge and technology; spin-off companies; preservation, curation and dissemination of data and results (as provided for in the Open Science policy); promotion of scientific and technological culture and citizen science; actions of special relevance to society, of a scientific, technological, cultural, artistic, social or economic nature; plans for gender equality and inclusiveness and policy of privacy concerning data management and processing. Include other aspects considered relevant.

Maximum 10 000 characters

International collaborations

International agreements with Imperial College London, AIST, NII, RIKEN, NARLABS, and the Cyprus Institute enable collaboration among scientists in shared scientific areas. Short-term mobility opportunities with the OpenInnoTrain project, the Texas Advanced Computing Centre, the Portugal-US Programme Partnerships, NII, AIST, and NARLABS add up.

From 2018 to 2023, 40% of INESC TEC publications had international co-authors, and 33% of its total funding came from international sources, including EU funding and international R&D services and consulting. In 2020, the INESC Brussels Hub was established to strengthen the five INESC institutes in European programmes, enhance their visibility and credibility in key fields, represent them on European platforms and structures, and offer researchers a space for support and representation. INESC TEC enhanced its engagement in projects related to the European Knowledge Innovation Communities (KICs), EIT Raw Materials, and EIT Manufacturing, along with participating in the calls of the Horizon Europe Programme. Finally, the INESC TEC International Visiting Researcher Programme allows up to 15 researchers from foreign institutions to engage in research activities at INESC TEC for a maximum of three months each year.

Evidence of proactivity in seeking co-financing

INESC TEC researchers engage in scientific activities across all TRLs and actively pursue and obtain funding from diverse sources competitively. As an illustration, in 2023, INESC TEC participated in projects funded by EU Framework Programmes H2020, Horizon, INTERREG (115), the National R&D Programmes funded by FCT (33), National programmes with industry funded by the Agência Nacional de Inovação (ANI) (63), the PRR - Portuguese Recovery and Resilience Plan (28). Relevant funding from large-scale strategic projects such as FCT's Multiannual funding, regional funding for highly qualified human resources (CCDRN), large infrastructures and funding for Technology and Innovation Centres funded by ANI, the Associate Laboratory funding, and Calls to Scientific Employment Stimulus. In 2023 only, INESC TEC researchers submitted proposals to calls: PRIMA – Section 2 (FCT) (1), Prémio Belmiro de Azevedo (1), ERANET (2), Portugal Tourism Office's Support to Meetings (2), PROdex for Science in Space Exploration: 1, Human Frontier Science Program (1), BIP Proof (2), European Tenders (2), HORIZON Europe (93), Digital Europe Programme - EUROHPC (2), European Defence Fund: (4); Interregional Innovation Investments Instrument - I3 (1), EU4Health Programme (1), European Space Agency: (1); EIT RAW Materials and EIT Manufacturing (2), COST Actions (2), Cascade Funding (1).

Advanced training

INESC TEC researchers supervised, on average, 600 MSc students and 275 PhD students per year. Moreover, INESC TEC organises yearly +10 advanced consulting and training courses in Technology and Advanced Production Technologies for companies and other organisations. In 2023, a partnership with Porto Business School was established to launch an Executive Master in Cybersecurity.

Scientific training of young students

INESC TEC is deeply engaged with Ciência Viva to foster scientific outreach among younger generations, acting as the host institution for summer internship programmes -"Summer with Science", participation in events such as the European Researchers' Night, Mostra U.Porto, and the International Science Festival. Other initiatives include the collaboration with 23 schools on an educational initiative focused on energy efficiency and energy poverty; the promotion of webinars, as part of an educational component of the CAMões project, targeting schools in mainland Portugal, Madeira, the Azores, the United States of America, Puerto Rico, Indonesia, and South Africa.

Organisation of conferences

On average, per year, INESC TEC researchers had +70 leadership positions and +270 participations in the TPC of international events.

INESC TEC organised +60 conferences, workshops, and scientific sessions, reaching over 4800 participants per year. Notably, INESC TEC has organised EUROSYS 2018, FM 2019, PSCC 2020 and 2022, EUCNC 2021, DSAA 2021, DS 2023, EMSLIBS 2023, and VISUM Summer School 2018-22.

Patents, prototypes or products and transfer of technology

From 2018 to 2023, INESC TEC's Technology Licencing office tracked 178 new R&D results, 38 new priority patent applications for new inventions, and 162 patent applications, including 42 in Europe, 39 national, 22 in the USA, 11 in China, 9 in Japan, 5 in South Korea, and others, 47 patent grants, and 15 commercial contracts for direct IP value-adding activities like licences, sales, and options. INESC TEC is in the top 30% of organisations with the most mapped results in the ASTP annual report listing 519 Technology Transfer Offices from universities and research institutes in 26 countries.

INESC TEC's performance falls within the average range for the number of new patents and patent grants, but it stands out for its high grant rate, reaching around 85% of the filed applications, due to the quality of the submissions. The institute prioritises internationalisation due to its focus on developing global solutions, being the only Portuguese entity consistently listed among the top national applicants for European patent applications (EPO Patent Index) for six consecutive years (since 2018).

Spin-off companies

To promote and value the institute's intellectual property (IP), INESC TEC encourages the establishment of technology-based spin-offs. During the reporting period, INESC TEC supported the development of several entrepreneurship endeavours, namely through its Laboratory for Technological Entrepreneurship (LET-In), offering accelerator programmes, training, and mentorship for technology-based entrepreneurial projects. The institute formally launched

6 spin-offs: Ubrider, Insignals Neurotech, Keyruptive Technologies, UNEXMIN Georobotics, Mitmynd and Seedsight (established in 2023, it will join one of the US Techstars acceleration programmes in 2024).

Preservation, curation and dissemination of data and results

INESC TEC is committed to the principle of publication of research data as an essential condition for the reproducibility of research, aiming to facilitate the access, sharing, and reuse of research data. INESC TEC has established an institutional data repository since 2017, in accordance with European principles on open data. At the end of 2023, the repository had a cumulative total of 133 accessible datasets.

Promotion of scientific culture and citizen science

The annual "INESC TEC Autumn Forum" aims to foster discussions of national relevance from an economic to a public policy point of view, focusing on those where science and technology is impactful. Furthermore, the institute publishes the biannual magazine "INESC TEC Science & Society," aimed at citizens interested in general knowledge about research, its applications, and its impact on society, as well as informed opinions on the public policies most influenced by technology. Following this line of engagement, the first season of the INESC TEC podcast and videocast series "INESC TEC Science and Society" with a focus on artificial intelligence and health, was launched. Furthermore, the podcast "INESC TEC's Science Bits" was nominated for the "Science, Technology, and Education" category of the 2023 PODES awards, recognising podcasts at a national level across various domains.

Actions of special relevance to society

INESC TEC promotes academic research's social relevance and societal endogenisation, making significant contributions to S&T policy over 35 years. Two notable cases support public policies in emergency situations: the previously stated Stayaway COVID system and the aid provided during the Borba quarry accident. As a result of the collapse of a section of the municipal road connecting Borba and Vila Viçosa on November 19, 2018, several automobiles became submerged in a water-filled quarry pit, resulting in fatalities. The Portuguese Navy requested INESC TEC assistance with EVA underwater robot to locate submerged vehicles at a time of great national emotion.

In 2022, our researchers achieved a significant milestone in the field of robotics and autonomous systems by setting a new world record in the Czech Republic, successfully exploring the "Hranice Abyss," the deepest natural cave in the world, reaching a depth of 450 metres. The UX-1Neo robot independently carried out exploration trips, revolutionising cave mapping by advancing in just two days what previously took 50 years.

Another illustration is the project IDINA which seeks to establish a robust and all-encompassing identity platform accessible to all individuals, particularly in nations lacking centralised identifying systems. In 2021, this proposal won the "IN3+ Award", whose primary aim was to jumpstart innovative concepts with global impact, granting €600K to develop and implement the solution.

Plans for gender equality, inclusiveness and policy of privacy

INESC TEC established a Diversity and Inclusion Commission in 2021, focused on gender balance and promoting diversity and inclusion. Since its inception, the commission launched a Gender Equality Plan 2022-2026, shared the results of a D&I survey, and organised awareness-raising and competency-building initiatives, including training sessions, events, and communication about important dates and cultural celebrations.

INESC TEC adheres to data protection laws, with its Data Protection Officer overseeing compliance, responsibilities, training, and audits for staff involved in processing operations.

5.5 Explain to what extent the proposed activity plan for the period between 2018-2023 was fulfilled, indicating and justifying any deviations from this plan

In the case of a merge of previous units, present the results for each R&D Unit. This section is not applicable to new R&D Units.

Maximum 4 000 characters

The proposed activity plan for the reporting period (initially submitted for 2018–2022 and later expanded) was entirely fulfilled. In many aspects, as summarised below, its actual execution, results, and outcomes over the reporting period exceeded expectations despite several unforeseeable challenges, namely the COVID-19 pandemic.

The activity plan was aligned with the institute's motto, "From knowledge production to science-based innovation", and it incorporated the concept of an end-to-end knowledge value chain. It focused on three main aspects: Research Excellence, International Relevance, and Knowledge Value, which were key to the plan's success.

Research Excellence

Centred on the "Challenge of Pervasive Intelligence", INESC TEC fulfilled its proposed targets: its scientific productivity grew consistently in terms of articles in indexed journals and first-tier conferences, fully aligned with Open Science good practices. It maintained its association and support to 19 doctoral programmes in several higher education institutions, as well as supervised more than 3600 MSc and 274 PhD concluded theses. INESC TEC researchers served on the editorial boards of over 600 journal publications and on the program committees of more than 1600 international events.

INESC TEC surpassed its goal of establishing 51 additional positions for individuals with PhD degrees. It effectively recruited 68 PhDs, representing a growth of 213% in comparison to the end of 2017. In fact, regarding scientific employment, INESC TEC largely exceeded its initial expectations, offering full contracts and a stable trajectory to 238 researchers. This evolution compensates for the decrease in post-doc grant holders, in line with the Portuguese Government's policy on scientific employment.

As planned, INESC TEC effectively obtained several funding sources to maintain and improve its state-of-the-art research infrastructures, which are essential for supporting research and technology transfer efforts.

International Relevance

International co-authors contributed to 40% of INESC TEC publications. Additionally, a third of its overall funding came from international sources, including EU funding and R&D Services and Consulting.

On average, INESC TEC participated in 64 European projects simultaneously. The fact that INESC TEC coordinated 21 out of a total of 137 projects during the reporting period demonstrates the institute's expertise in European research collaborations. Notably, INESC TEC led and launched the INESC Brussels Hub in 2020. This hub serves as its joint representation with four other national institutions near the EU.

INESC TEC's contributions to various EU initiatives, such as MANUFUTURE-EU, EuroHPC JU, Euro Working Group on Retail Operations, Eureka Eurostars, EARTO were significant, with key roles as coordinators, advisors, and experts, contributing to strategic advancements in the EU.

INESC TEC researchers have maintained an active collaboration with the MIT Portugal, CMU Portugal, and UT Austin Portugal programmes, with the institution acting as the national coordinator of the latter since 2018. Moreover, INESC TEC celebrated MoUs for scientific collaboration and exchange programmes with international institutions in Europe, America, and Asia. Remarkably, INESC P&D Brasil maintained a trajectory of sustained growth.

INESC TEC joined 14 international associations in diverse scientific domains (6G, AI, IoT, Energy, Bioengineering, and Photonics), notably in the European Knowledge and Innovation Communities (KICs) EIT Raw Materials and EIT Manufacturing.

Knowledge Value

INESC TEC has had an uninterrupted presence in the Top 10 of the European Patent Office's national "Patent Index" as the result of a sustainable IP portfolio management strategy. It supported the launch and development of 6 spin-offs (section 5.4) and provided, on average, 3.5M€ of R&D Services and Consulting to national and international industry and Public Administration.

06 Reports and External Advisory Board Members

6.1 Reports of the External Advisory Board in 2018-2023

(not applicable for new R&D Units)

Attach one or more PDF files with the External Advisory Board reports for the period between January 1, 2018 and December 31, 2023. In the case of a merge of previous units, submit the reports of the respective External Advisory Boards.

Maximum 5MB per file and 50MB in total files.

File “2021_INESC TEC_SAB Report” uploaded

File “2023_INESC TEC_SAB Report_Ad Hoc Review Committee” uploaded

6.2 Composition of the current External Advisory Board

(optional for new R&D Units)

Indicate the most recent composition of the R&D Unit's External Advisory Board. In case of a merge of previous units, indicate the most recent composition of the respective External Advisory Board.

For each member of the Board, indicate the name and institution to which they are affiliated, and the country of affiliation of the institution.

In the case of a merge of previous units, for each Board indicate the respective previous R&D Unit.

Name of the R&D Unit	Member Name	Institution	Country
INESC TEC	José Fortes	University of Florida	USA
INESC TEC	Anne-Marie Kermarrec	EPFL - L'Ecole Polytechnique Fédérale de Lausanne	Switzerland
INESC TEC	Edward Knightly	Rice University	USA
INESC TEC	Elsa Angelini	Telecom Paris	France
INESC TEC	John J. Leonard	MIT, Department of Mechanical Engineering	USA
INESC TEC	Maria Grazia Speranza	Università degli Studi di Brescia	Italy
INESC TEC	Mario Paolone	EPFL - L'Ecole Polytechnique Fédérale de Lausanne	Switzerland
INESC TEC	Masaru Kitsuregawa	Institute of Industrial Science, The University of Tokyo	Japan
INESC TEC	Robert Lieberman	SPIE – The International Society for Optics and Photonics; Lumoptix LLC	USA
INESC TEC	Tomás Gómez San Román	Universidad Pontificia Comillas	Spain
INESC TEC	Volker Stich	Aachen University of Technology	Germany

07 Funding during 2018-2023

(optional for new R&D Units)

7.1 Annual funding in 2018-2023 *(optional for new R&D Units)*

For the period between January 1, 2018 and December 31, 2023, indicate the global amounts (in thousands of euros) received from any source, relating to the R&D Unit's research activities separated by funding sources as indicated in the table.

FUNDING SOURCES (TOTAL FUNDING)	2018	2019	2020	2021	2022	2023	TOTAL (K€)
Fundação para a Ciência e a Tecnologia, I.P. - FCT	€ 6 147	€ 7 773	€ 7 951	€ 6 896	€ 7 307	€ 6 971	€ 43 045
R&D Unit Pluriannual funding (base and programatic)	€ 2 485	€ 2 237	€ 2 396	€ 2 257	€ 3 062	€ 2 442	€ 14 879
R&D Project funding	€ 2 279	€ 3 677	€ 3 524	€ 2 295	€ 1 522	€ 1 428	€ 14 725
Funding for contracts of researchers with PhD (1)	€ 169	€ 441	€ 460	€ 484	€ 509	€ 732	€ 2 795
Scholarship funding for PhD, PostDoc or other fellowships (2)	€ 1 000	€ 1 103	€ 1 301	€ 1 599	€ 1 849	€ 1 982	€ 8 834
Other funding	€ 214	€ 315	€ 270	€ 261	€ 365	€ 387	€ 1 812
Other national sources	€ 6 846	€ 5 705	€ 5 717	€ 7 656	€ 8 634	€ 12 918	€ 47 476
Funding received from Participant or Management Institutions	-	-	-	-	-	-	-
Public sources (3)	€ 3 694	€ 2 426	€ 2 134	€ 3 838	€ 4 759	€ 9 782	€ 26 633
Companies, industry and other private sources based in Portugal (3)	€ 2 525	€ 2 527	€ 2 899	€ 3 519	€ 3 527	€ 2 726	€ 17 723
Any other funding source (3)	€ 627	€ 752	€ 684	€ 299	€ 348	€ 410	€ 3 120
International sources	€ 4 844	€ 5 033	€ 5 750	€ 6 656	€ 8 502	€ 10 442	€ 41 227
European Commission (3)	€ 3 628	€ 3 910	€ 4 903	€ 5 529	€ 7 642	€ 9 273	€ 34 885
Companies, industry and other private sources not based in Portugal (3)	€ 509	€ 410	€ 547	€ 678	€ 326	€ 579	€ 3 049
Other funding sources (3)	€ 707	€ 713	€ 300	€ 449	€ 534	€ 590	€ 3 293
Total (K€)	€ 17 837	€ 18 511	€ 19 418	€ 21 208	€ 24 443	€ 30 331	€ 131 748

08 Integrated PhD holder researchers, PhD students and research contracts in 2018-2023

8.1 Integrated PhD holder researchers, PhD students and total research contracts in each year in the period 2018-2023 (optional for new R&D Units)

For the period between January 1, 2018 and December 31, 2023, fill in the table with the numbers of integrated PhD holder researchers, PhD students with theses supervised (ongoing or concluded) by integrated researchers from the R&D Unit, and research contracts. In the case of a merger of previous R&D Units, indicate the respective sums.

Researchers and students	2018	2019	2020	2021	2022	2023
No. of integrated PhD researchers	339	341	354	342	364	381
No. of PhD students supervised by PhD integrated members of the R&D Unit (ongoing)	190	244	263	278	221	305
No. of PhD students supervised by PhD integrated members of the R&D Unit (concluded)	67	34	43	52	45	38
No. of contracts with national public or private entities	186	226	227	233	233	221
No. of contracts with international bodies	67	81	110	102	113	140

8.2 Measures implemented in the development of scientific careers (optional for new R&D Units)

Indicate the measures implemented by the R&D unit, and the achieved results, to support and develop scientific careers in their different stages, considering, in particular, efforts made to integrate researchers into permanent career positions. It should also include training and development, coaching and mentoring opportunities provided by the R&D unit to researchers, in particular, early career researchers.

Maximum 4 000 characters.

At INESC TEC, research excellence and researchers' professional growth are symbiotic. Following a large-scale "Climate Survey" - which assessed researchers' perception of INESC TEC- the importance of robust career support appeared as crucial for retaining and attracting talent, so an 'HR Centre of Excellence on Careers" was established. This initiative involved researchers at various career stages to ensure a diversity of perspectives in developing best practices and policies for career development. It applies not only to hired researchers but also to HEI researchers, who also need a development perspective and a career path within the organisation.

Strategic Framework for Career Development

Recruitment and Integration into Permanent Positions

Strategy and Implementation: Two significant actions were implemented: a policy enabling promising researchers to evolve to permanent positions and the regular opening of permanent positions through international competitive calls in strategic areas. Regular strategic reviews follow both processes.

- **Outcomes:** From 2018 to 2023, this initiative successfully converted 97 term contracts to permanent terms (initially contracted via international tender), significantly sustaining job stability and motivation within research teams, and opened ten permanent positions through international tender.

Training and Development Programs

Comprehensive Learning Strategy: Annual assessment of the training needs of our researchers to ensure development in both technical and non-technical skills (leadership, work-life balance, etc).

- **Implementation and Impact:** Tailored training programs were developed, with approximately 500 hours of training provided in the first 12 months. Feedback via evaluation forms consistently shows high satisfaction, confirming the approach's effectiveness.

Coaching and Mentoring

Regular coaching and mentoring actions take place to foster researchers' personal and professional development. Experienced researchers are paired with early career colleagues to offer guidance on R&D challenges and project management.

Mentoring Programs: Regular group and one-to-one mentoring sessions support young researchers through R&D and project management challenges.

- **Impact of Mentoring:** Participants in the mentoring programs report improved confidence in their research abilities, increased success in securing research funding, as well as in project and people management.

Mobility and Career Progression

Career Development: To align skills with the institute's evolving research demands, strategic mobility and advancement of researchers were a priority to enhance scientific impact and professional growth.

- **Mobility Measures:** A thorough analysis of research teams was conducted to identify researchers whose scientific impact had been decreasing. As a result, eight researchers were reallocated to other R&D Centres where their competences were better aligned, with clear improvement in their scientific output.
- **Progression and Promotion Measures:** The performance appraisal process is based on qualitative and quantifiable research outputs, such as publications, project involvement and proposal submissions. This annual process resulted in the progression of 185 and the promotion of 34 researchers, thus reinforcing the commitment to recognise and reward relevant contributions to INESC TEC research objectives.
- **Special Support Initiative for Early Career Researchers:** To address the specific needs of early career researchers, INESC TEC implemented a transparent promotion process for post-docs reaching their fifth year following FCT regulation. This process involves a jury assessment supported by the Scientific Council, ensuring fairness and transparency.

Conclusion

Creating an attractive and dynamic environment for researchers has been a top priority at INESC TEC, continuously refining policies and practices to ensure that it remains at the forefront in fostering innovative research careers.

Part 3: Research team with links to CVs and ORCID record

(All information in this section is pre-filled with the data previously confirmed in the Team Registration menu and therefore cannot be changed.)

09 Lists of researchers in the current application

9.1 List of Integrated PhD holder Researchers in the R&D Unit

List with the names of integrated PhD holder researchers, with CIÊNCIA ID, link to CIÊNCIAVITAE, ORCID and time dedication (%).

List closed in "Phase 2 – Team registration". The information is available in Annex I, distributed among the Research Groups (corresponding to sections 12.2 of Phase 3).

9.2 List of Collaborating Researchers of the R&D Unit

List with the names of the Collaborating Researchers of the R&D Unit.

List closed in “Phase 2 – Team registration”. The information is available in Annex I, distributed among the Research Groups (corresponding to sections 12.2 of Phase 3).

9.3 List of PhD students supervised by integrated PhD holder researchers in the R&D Unit

List with PhD students supervised by integrated PhD holder researchers from the R&D unit.

List closed in “Phase 2 – Team registration”. The information is available in Annex I, distributed among the Research Groups (corresponding to sections 12.2 of Phase 3).

Part 4: Activity Plan for 2025-2029

10 Summary of the Activity Plan for 2025-2029

10.1 Summary in Portuguese for publication

Summary in Portuguese to be used by FCT to publicize the R&D Unit's Activity Plan. This summary may or may not correspond to what is requested below for evaluation purposes. The information provided in this field will be the responsibility of the R&D Unit coordinator.

Maximum 3 000 characters.

O Plano de Atividades do INESC TEC para 2025-2029 é um plano abrangente estruturado em torno de nove dimensões estratégicas, alinhadas com o Plano Estratégico 2030 da instituição.

As principais dimensões estratégicas são:

- **Avanço e Aplicação do Conhecimento:** liderar na criação de conhecimento com foco em publicações de alta qualidade, assente em colaborações interdisciplinares, envolvimento da indústria e infraestruturas de investigação de ponta.
- **Internacionalização:** aumentar a contribuição para agendas internacionais através do envolvimento com instituições relevantes, atração de investigadores de classe mundial e aumento do envolvimento em programas de financiamento internacionais.
- **Formação Avançada e Programas de Doutoramento:** liderar na formação avançada, incluindo programas conjuntos de classe mundial e programas de pós-graduação cocriados com Instituições de Ensino Superior (IES) e indústria.
- **Mentoria e Desenvolvimento de Carreira:** promover a excelência, fornecendo mentoria personalizada, especialmente na fase inicial, e explicitando os percursos de desenvolvimento de carreira.
- **Transferência de Conhecimento:** aumentar o impacto social através de mecanismos de valorização de conhecimento, como identificação, proteção e comercialização de propriedade intelectual.

Outras dimensões estratégicas incluem Disseminação e Envolvimento, Ciência Aberta e Impacto Social, Parcerias e Redes, Abertura, Igualdade e Privacidade, e Excelência Operacional.

O modelo de gestão científica do INESC TEC implementa o conceito de cadeia de valor de conhecimento de ponta a ponta. A investigação está estruturada em oito grandes Domínios Científicos, que articulam os investigadores centrados nos respetivos tópicos de investigação: Inteligência Artificial, Bioengenharia, Comunicações, Ciência e Engenharia dos Computadores, Fotónica, Sistemas de Energia, Robótica e Engenharia e Gestão de Sistemas. A operacionalização deste modelo está a cargo de 13 Centros de I&D, de 5 plataformas de estruturação das solicitações do mercado, e de uma equipa técnica e administrativa altamente qualificada.

No sentido de capitalizar toda a sua massa crítica e multidisciplinaridade, o INESC TEC estabeleceu quatro desafios de investigação transversais, que contribuem para o cumprimento da sua missão: Modelos Digitais, Tecnologia Confiável, Enfrentar Desafios Extremos e Transformação Sustentável.

O INESC TEC está empenhado em manter infraestruturas de investigação de ponta, fundamentais no desenvolvimento de tecnologias alinhadas com os seus objetivos estratégicos e na atração de talento de alto nível para os programas de mestrado e doutoramento.

Em conclusão, o Plano de Atividades do INESC TEC para 2025–2029 é um plano abrangente que delinea o compromisso da organização com o avanço do conhecimento e com o aumento do impacto social.

10.2 Summary in English for publicity purposes

Summary in English for publication corresponding to the previous summary in Portuguese.

Maximum 3 000 characters.

INESC TEC's Activity Plan for 2025–2029 is a comprehensive plan structured around nine strategic dimensions, aligned with INESC TEC's Strategic Plan 2030 and its purpose, vision, and mission.

Key Strategic Dimensions are:

- **Advancement and Application of Knowledge:** lead in interdisciplinary knowledge creation and application with focus on high-quality publications, interdisciplinary collaborations, industry engagement, and state-of-the-art research infrastructures.
- **Internationalisation and International Collaboration:** enhance its contribution to international agendas by engaging with international institutions, attracting world-class researchers, and boosting involvement in international funding programs.
- **Advanced Training and PhD Programmes:** lead in advanced and scientific training, including world-class interdisciplinary training programs and postgraduate programs co-created with Higher Education Institutions (HEIs) and industry.
- **Mentoring and Career Development:** nurture excellence by providing tailored coaching and mentoring, especially early in careers, and enhancing career development pathways.
- **Knowledge Transfer:** enhance societal impact through effective knowledge valorisation and transfer mechanisms, such as identification, protection, and commercialisation of intellectual property.

Other strategic dimensions include Dissemination and Engagement, Open Science and Societal Impact, Partnerships and Networks, Openness, Equality, and Privacy, and Operational Excellence.

INESC TEC's science management model implements the concept of an end-to-end knowledge value chain. Research is structured in eight broad Scientific Domains, each including researchers producing on research topics central to the domain: Artificial Intelligence, Bioengineering, Communications, Computer Science and Engineering, Photonics, Power and Energy Systems, Robotics, and Systems Management and Engineering. To implement these domains, INESC TEC fully leverages thirteen research and development centres (R&D Centres); strategy-driven platforms tackling market demands; and a highly skilled technical and administrative staff.

To capitalise on its critical mass and multidisciplinary nature, INESC TEC has established four cross-cutting research challenges, with transdisciplinary nature and contributing to the fulfilment of its mission: Digital Models, Trustworthy Technology, Tackle the Extreme, and Sustainable Transformation.

INESC TEC is committed to maintaining state-of-the-art research infrastructures, instrumental in developing technologies aligned with INESC TEC's strategic goals and in attracting top-tier talent for MSc and PhD programs.

In conclusion, INESC TEC's Activity Plan for 2025–2029 is a comprehensive blueprint that outlines the organisation's commitment to advancing knowledge, fostering international collaboration, providing advanced training, enhancing societal impact, and promoting scientific and technological culture.

10.3 Summary in English for assessment purposes

Summary in English for assessment purposes.

Maximum 6 000 characters.

INESC TEC's Activity Plan for 2025–2029 details and emphasises the aligned endeavours of its researchers towards the advancement and application of knowledge, internationalisation, international collaboration, advanced training, and career development. The plan is structured around nine strategic dimensions aligning with the organisation's Strategic Plan 2030, and with its purpose, vision, and mission.

Advancement and Application of Knowledge

INESC TEC aims to lead in the creation of interdisciplinary knowledge within its eight Scientific Domains: Artificial Intelligence, Bioengineering, Communications, Computer Science and Engineering, Photonics, Power and Energy Systems, Robotics, and Systems Management and Engineering and promote its technological and societal application responding to four cross-cutting research challenges: Digital Models, Trustworthy Technology, Tackle the Extreme, and Sustainable Transformation.

The strategy includes a focus on top-quality publications, interdisciplinary collaborations, industry engagement, state-of-the-art research infrastructures, open access policies, participation in international consortia, and stronger connections with innovation partners.

Internationalisation, International Collaboration, and Infrastructures of International Relevance

The goal is to enhance INESC TEC's contribution to international agendas and its role in tackling universal challenges. The plan involves engaging with international institutions, internationalising at home, attracting world-class researchers, boosting involvement in international funding programmes, participating in R&I agenda-setting, and strengthening integration into global value chains.

Advanced Training and PhD Programmes

INESC TEC aims to lead in advanced and scientific training and develop the next generation of researchers and innovators. The strategy includes world-class interdisciplinary training programmes, postgraduate programmes co-created with Higher Education Institutions (HEI) and industry, international partnerships for joint degrees and exchanges, and working with non-academic stakeholders.

Mentoring and Career Development

The organisation aims to nurture excellence by providing tailored career development plans especially for early career researchers. The plan includes coaching and mentoring programmes, workshops in career planning and other advancement areas, advanced training through annual diagnosis survey and transferable skills training for personal development.

The plan includes further measures to integrate researchers into permanent career positions, such as the strong commitment on the implementation of the FCT Tenure program for promising researchers, both in positions at the HEI and in internal INESC TEC positions.

Knowledge Transfer

INESC TEC aims to enhance societal impact through effective knowledge valorisation and transfer mechanisms, such as identification, protection, and commercialisation of intellectual property, according to international standards for technology transfer. It will also support entrepreneurship training programmes to facilitate the transition of research into market-ready innovations.

Moreover, it will ensure the preservation, curation, and dissemination of data and results through Open Science (OS) and contribute to society across diverse spheres.

Additional strategic dimensions

Other strategic dimensions include Dissemination and Engagement, Societal Impact, Partnerships and Networks, Openness, Equality, and Privacy, and Operational Excellence. Each dimension is interwoven with five commitments

reflecting INESC TEC's strategic intent, such as commitment to innovation, collaboration, societal impact, sustainability, and excellence.

The organisation's science management model implements the concept of an end-to-end knowledge value chain, driving knowledge from its generation in research activities to its valorisation through different technology transfer instruments. The organisation's science management model implements the concept of an end-to-end knowledge value chain, driving knowledge from its generation in research activities to its valorisation through different technology transfer instruments. Research at INESC TEC is structured around eight broad Scientific Domains, each including researchers producing on research topics central to the domain: Artificial Intelligence, Bioengineering, Communications, Computer Science and Engineering, Photonics, Power and Energy Systems, Robotics, and Systems Management and Engineering.

INESC TEC has established four cross-cutting research challenges that are decisive to its vision and receiving contributions from multiple scientific domains: Digital Models, Trustworthy Technology, Tackle the Extreme, and Sustainable Transformation. These challenges have a transdisciplinary nature and contribute to the fulfilment of INESC TEC's mission.

In order to implement its scientific management model, INESC TEC fully leverages thirteen research and development centres (R&D Centres); strategy-driven platforms known as TEC4 initiatives, which tackle and impact significant societal issues and market demands; and a highly skilled group of technical and administrative staff members divided into three departments: business development, organisation and management, and technical support.

INESC TEC is also strongly committed to developing and maintaining state-of-the-art research infrastructures. These are instrumental in developing technologies aligned with INESC TEC's strategic goals and attracting top-tier talent for MSc and PhD programmes, which are critical for advancing scientific knowledge.

To conclude, INESC TEC's Activity Plan for 2025–2029 is a comprehensive blueprint that outlines the organisation's commitment to advancing knowledge, fostering international collaboration, providing advanced training, enhancing societal impact, and promoting scientific and technological culture.

11 Description of the Activity Plan for 2025-2029

11.1 Objectives and strategy of the R&D Unit for 2025-2029

Describe the R&D Unit's objectives, strategy and goals for 2025-2029, including contributions to the advancement and application of knowledge, internationalization, international collaboration, advanced training, scientific training, coaching and mentoring, and prospect for career development provided by the R&D Unit to researchers, in particular, early career researchers, conditions for developing PhD programs in close collaboration with the R&D Unit, organization of conferences, colloquia or seminars, transfer of knowledge and technology, preservation, curation and dissemination of data and results (as provided for in the Open Science policy), promotion of scientific and technological culture and citizen science, actions of special relevance to society, of a scientific, technological, cultural, artistic, social or economic nature, partnerships, including special relationships with other R&D Units or participation in Associated Laboratories or other interinstitutional collaboration, and participation in infrastructures of international relevance. Plans for integrating researchers into permanent career positions, particularly R&D Unit interinstitutional partnerships established to implement the FCT-Tenure program, namely the Research Unit Chair positions (Cátedras UI), whenever suitable, should be highlighted. Include other relevant aspects, namely plans concerning Open Access, gender equality, inclusiveness, and data privacy.

Maximum 10 000 characters.

INTRODUCTION

Our Strategic Plan 2030 is the overarching framework for our activities in science and innovation. This section offers an organised and updated overview of the plan's most relevant elements for this application.

As part of this framework, our purpose, vision, and mission are key pillars guiding our direction in alignment with nine strategic dimensions (SD):

- Our purpose - to create a fulfilling and sustainable future through impactful science, technology and innovation (ST&I) - most immediately stresses advancing and applying knowledge (SD1), aligning innovation with societal needs (SD6) and broadly benefiting stakeholders through Open Access (OA) (SD8).
- Our vision - to be an inspiring and empowering force, driving the S&T of digitally-enabled systems to overcome society's challenges - emphasises the broadening of our international footprint (SD2) and dissemination and engagement impact (SD5).
- Our mission - to take on bold ST&I challenges, empowering talent, ecosystems and public policies - further accentuates advanced training and education (SD3), mentoring and career development (SD4), equality and inclusion (SD8), efficient infrastructure (SD9), and partnerships and networks (SD7).

These nine dimensions connect our pillars with goals, objectives and strategies.

SD1 ADVANCEMENT AND APPLICATION OF KNOWLEDGE

We aim to lead in interdisciplinary knowledge creation and its technological and societal application, and enhance our scientific and societal relevance.

Our objectives and strategies include a focus on top-quality publications addressing key scientific and societal challenges; interdisciplinary collaborations among our scientific domains unlocking multifaceted discovery avenues; industry engagement in projects and knowledge transfer, raising our practices to international standards; state-of-the-art labs and computational tools for impactful research; OA policies to amplify idea exchange and impact; participation in international consortia for diversity of perspectives and global footprint enhancement; deeper relationships with innovation partners, establishing industry-funded programs, systematising collaboration, and benefiting local communities through e.g. fellowships.

SD2 INTERNATIONALISATION, INTERNATIONAL COLLABORATION AND INFRASTRUCTURES OF INTERNATIONAL RELEVANCE

We aim to enhance our contribution to international agendas and our role in tackling universal challenges.

Towards these goals, we will engage with international institutions, networks and infrastructures in projects, exchanges and resource sharing; internationalise at home, hosting international scholars and organising global conferences; attract world-class researchers and students, with competitive, inclusive conditions; boost involvement in international funding programs, with dedicated support for ambitious proposals; participate in R&I agenda-setting, increasing advisory and policy contributions, leveraging our Public Policy Office; strengthen our integration in international value-chains through EU Public-Private Partnerships and other consortia; enhance international collaboration, mobility and culture through our International Relations Service; boost visibility using international digital platforms and media.

SD3 TRAINING AND PHD PROGRAMS

Our goals include leading in advanced and scientific training and developing the next generation of researchers and innovators, particularly in preparing PhD students for diverse and challenging careers.

Their pursuit will leverage world-class interdisciplinary training programs merging technical and soft skills, and post-grad programs and PhD tracks co-created with HEIs and industry, blending academic rigour and application exposure; international partnerships for joint degrees and exchanges, enriching academic and cultural experiences; cultivating diversity among PhD students and researchers; working with non-academic stakeholders in alignment with industry and societal needs.

SD4 MENTORING AND CAREER DEVELOPMENT

We aim to nurture excellence by enhancing career development pathways, smoothing transitions into permanent positions in HEIs, industry, or research organisations (ROs), strengthening our ecosystems.

Objectives and strategies include fine-tuning the internal performance assessment system, coaching and mentoring programs that value diverse perspectives; workshops in career planning, grant writing and other advancement areas; transferable skills like communication, project management and entrepreneurship; clear and attainable career development pathways, supported by appropriate resources and opportunities; programs with HEIs and ROs to support transitions into permanent positions, leveraging initiatives such as the FCT-Tenure Program and access to international networks; strengthening career development partnerships, emphasising industry-sponsored opportunities.

SD5 DISSEMINATION AND ENGAGEMENT

We will be a reference hub for S&T exchange, showcasing excellence, fostering dialogue, promoting scientific literacy and engaging the public through citizen science.

In pursuit of these goals, we will organise high-quality events attracting global participants, namely through international scientific collaborations; develop citizen science projects, use online engagement and hold lectures and exhibitions to demystify science and demonstrate its everyday relevance; communicate science comprehensively via social media and innovative technologies and promote scientific literacy, curiosity and innovation; showcase impactful interdisciplinary projects.

SD6 KNOWLEDGE TRANSFER, OPEN SCIENCE AND SOCIETAL IMPACT

We aim to enhance societal impact through effective knowledge transfer mechanisms, ensure the preservation, curation, and dissemination of data and results through Open Science (OS), and contribute to society across diverse spheres.

These goals involve evolving our technology transfer, industry liaison and entrepreneurship support processes and offices; enhancing our OS infrastructure, including data repositories and training on principles, management and ethics; engaging with societal impact, advancing digital and sustainability transitions and tackling societal challenges and SDGs; using outreach tools to inform public and stakeholders on impactful contributions to society; develop projects with cultural, social and economic development organisations to benefit their communities.

SD7 PARTNERSHIPS AND NETWORKS

We will solidify our position in the research landscape through strategic partnerships and collaborative networks to enhance research excellence, innovation and societal impact, and foster an ecosystem spanning disciplines and economic and social sectors.

These goals will benefit from a structured partnership approach, reflected in agreements committing shared projects and resources, and regular assessments; initiatives with partners to combine expertise towards breakthrough discoveries and societal contributions; platforms to facilitate collaboration, new initiatives, knowledge exchange and innovation; enhancing international partnerships to enrich our ecosystem; training and support on collaborative management, partnership development and cross-sectoral communication.

SD8 OPENNESS, EQUALITY AND PRIVACY

Our goals are to lead by example in OA and make research broadly accessible, champion gender equality and inclusion to nurture diverse talent, uphold high privacy standards, safeguard research and personal data integrity and confidentiality.

We will evolve OA policies to the latest standards and prioritise OA journals and repositories to facilitate sharing, collaboration and innovation; implement our Gender Equality Plan and show progress with statistics and examples; provide training, awareness, and underrepresented group support to promote diversity; adopt data management and privacy protocols to ensure compliance, and provide training on responsible data handling and security best practices to maintain research trust and integrity; advance OS with other institutions and networks, promoting openness and access.

SD9 OPERATIONAL EXCELLENCE

We will ensure robust and sustainable operations, adaptable to evolving demands for an environment conducive to groundbreaking research.

To achieve these goals, we will evolve our digital tools to automate administrative tasks, manage data effectively and enhance communication and collaboration; streamline processes and adopt best practices; offer training on operational excellence; integrate sustainability in energy, waste and resource management; establish feedback processes for continuous improvement.

CONCLUSION

Each dimension in this blueprint is interwoven with five commitments reflecting our strategic intent:

- Excel and innovate across the missions of academia, harnessing the collective strength of our community - SD1 and SD3 highlight our commitment to collaborative excellence and innovation;
- Make an impact on the toughest challenges of our time in science, technology and society, through bold creativity and transformative action - SD5 and SD6 drive our research and innovation for societal advancement, while SD9 provides agility and depth to tackle these challenges;
- Increase our relevance by closely integrating across science and innovation, disciplines and ecosystems - SD1, SD2, and SD7 enhance our global S&T contributions, with SD8 ensuring our networks match the diversity and vibrancy of the communities we serve;
- Cultivate an attractive, people-centred and talented community - SD4 nurtures professional growth, while SD9 ensures efficient innovation-enabling support processes;
- Strive for a sound, sustainable and effective operational model – SD8 and SD9 ensure our goals are feasible, support an equitable, open environment and maintain essential pillars for knowledge sharing and innovation.

These commitments not only anticipate the future, they actively shape our collective impact.

11.2 Organization of the R&D Unit for 2025-2029

Describe and justify the R&D Unit structure planned for 2025-2029, including reference to Thematic Lines and Research Groups and how they are organized, if applicable. Describe the main processes for managing the activities of the R&D Unit, coordinating Thematic Lines and how the involvement of Research Groups is ensured. If the R&D Unit integrates researchers from several Participating and/or Management Institutions, it must be described how interaction with these institutions is planned.

Maximum 7 000 characters.

INESC TEC's management model implements the concept of end-to-end knowledge value chain, driving knowledge from its generation in research activities to its valorisation through different technology transfer instruments.

Research at INESC TEC is structured in eight broad Scientific Domains, mapped in this application as Research Groups: Artificial Intelligence, Bioengineering, Communications, Computer Science and Engineering, Photonics, Power and Energy Systems, Robotics, and Systems Engineering and Management.

Each of these domains includes researchers with scientific production on research topics central to the domain, with its team characterised by a set of scientific competences. The activity developed and to be developed in each domain is structured into research challenges. These challenges describe, in an aggregated form, the main medium-term ambitions for INESC TEC's research activity. Each domain has a Steering Committee – a small group of researchers from the domain team, asked to promote strategic thinking, guide the domain activity, and monitor its trajectory.

The Scientific Domains structure the institute's research competences and challenges promoting strategic thinking, trajectory monitoring, and science communication.

In terms of innovation, INESC TEC implemented strategy driven platforms addressing and impacting great societal challenges and market needs – the TEC4 initiatives. Currently addressing agro-food, energy, health, industry, and sea sectors, these initiatives tackle regional, national, international, or global/societal challenges and markets by mapping and linking its short, medium, and long-term needs with INESC TEC's scientific and technological competences and experience.

In operational and management terms, research, and innovation at INESC TEC are undertaken within each of its thirteen Research Centres. The Research Centres are INESC TEC's R&D base organisational units, each focused on specific scientific and technological areas and responsible for its own planning, strategy, and resources, reporting directly to the Board of Directors regarding budget and performance indicators. Each Centre has a Coordinating Council and one or two Coordinators.

High-level strategic decisions are made by the Board of Directors (BoD), composed of seven members and an Executive Board comprising four of those seven members. The Boards act in close coordination with the Council of R&D Centres, meeting with the Centre Coordinators, Domain representatives and the Managers of the different Support Services every other week. This ensures institution-wide coherence in vision, policy and operations, and joint responsibility and commitment in strategic and operational management decisions.

The Scientific Advisory Board comprises twelve internationally recognised scientists who support the institution's search for continuous improvement and excellence, building a vision for future research through a valuable benchmark at the international level. The external monitoring, orientation and evaluation of the technology transfer and innovation activities are entrusted to the Business Advisory Board, whose members have knowledge and experience in several economic sectors relevant to INESC TEC. The Scientific Council is an internal body responsible for monitoring and guiding scientific and technical activities, and it includes one representative from each Centre and three additional members appointed by the Board of Directors.

INESC TEC's activities are supported by a streamlined and dynamic team of highly qualified technical and administrative personnel, organised across the following areas: Business Development (Technology Licencing Office, Funding Opportunities, International Relations, and Communication), Organisation and Management, and Technical Support. The Technology Licencing Office performs a systematic monitoring of strategic projects to allow for the early identification of R&D results with valorisation potential, provides support for intellectual property (IP) rights registration (including patent application) and portfolio management, and contributes to IP awareness and training across the institution. The Communication Office oversees science communication and outreach activities.

The Audit Committee includes a Certified Public Accountant and oversees and validates the financial procedures and performance of the Institute.

Six non-statutory bodies oversee aspects that INESC TEC particularly values. The Ethics Committee ensures the observance and promotion of integrity, honesty, and responsibility standards in research activities carried out by INESC TEC's members, by implementing the institution's Code of Ethics. The Conflict of Interest Management Commission and the Data Protection Officer are responsible for implementing the institute's Policy on Conflicts of Interest Management and the General Data Protection Regulation, respectively. The Anti-Corruption Compliance Officer is responsible for implementing the Compliance Programme for the prevention of corruption in articulation with other relevant organisational units. The Technical Committee for Social Responsibility has as its mission the incorporation of social responsibility in the institution's organisational culture and practices. The Diversity and Inclusion Commission encourages the organisation to implement practices that promote diversity and inclusion and develops long-term work in this field by proposing and implementing a D&I Program for INESC TEC, including gender balance as a major priority. A new office has been set up to promote and articulate the institution's contributions to public policies.

As a multidomain research organisation, INESC TEC established four crosscutting research challenges that are decisive to INESC TEC vision and receive contributions from multiple scientific domains: Digital Models, Trustworthy Technology, Tackle the Extreme, and Sustainable Transformation. These crosscutting research challenges are presented in this application as Thematic Lines. They have a transdisciplinary nature and contribute to the fulfilment of INESC TEC mission as they amplify the impact of INESC TEC research. The coordination of each of them mainly consists in identifying research opportunities within its scope that can be tackled by joining competences from multiple scientific domains and putting up teams and research projects addressing them.

In terms of planning and reporting, framed in its Strategic Plan, annual Activity Plans and reports are produced every year, highlighting the main activities, and helping to monitor the performance of the institution in the different dimensions of its activity. The implementation of the Activity Plans is monitored quarterly, with assessment findings presented and discussed at broader coordination meetings, to ensure a wide knowledge of the plans' fulfilment status.

12 Proposed Research Groups

(only for units with more than 50 integrated PhD holder researchers, and optional for these)

Each R&D Unit may or may not organize itself into Research Groups, ***each with a Principal Investigator***. Regardless of the organization of the R&D Unit in this aspect, this section of the Application Form is only available for completion by R&D Units with more than 50 integrated PhD holder researchers, and it is optional.

12.1 AI - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Inteligência Artificial

12.1.3 Name of the Research Group in English

Maximum 100 characters

Artificial Intelligence

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.

Each keyword must be up to 50 characters long.

Computer Vision
Natural Language Processing
Data Stream Mining
Decision Support Systems

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Lightweight multilingual extraction of keywords in texts

Yake! is a feature-based system for multilingual keyword extraction [10.1016/j.ins.2019.09.013; 10.1007/978-3-319-76941-7_80], which supports texts of different sizes, domains or languages. It follows an unsupervised approach built upon statistical features extracted from the text, rather than common approaches such as the use of dictionaries or thesauri and training against corpora. Yake! is used by academics, often cited as state-of-the-art by the scientific community, companies and other institutions such as the National Library of Finland, schemawriter.ai and Arquivo.pt.

It has been reimplemented by JohnSnow Labs in their NLP distribution, licensed by Volkswagen and used to create the General Index, a project that catalogued 107 million scientific articles. It is available as a package, being used by more than 800 projects and having more than 1500 stars on GitHub. Research papers feature more than 1000 citations in Google Scholar. Reference [10.1007/978-3-319-76941-7_63] was the best short paper at the Euro. Conf. Information Retrieval in 2018.

Transparent Artificial Intelligence

Machine learning systems are becoming increasingly ubiquitous. We highlight our research line in privacy-preserving visual case-based explanations, formalised as a multi-objective problem to preserve privacy, intelligibility, and relevant explanatory evidence regarding a predictive task. We also proposed a novel method for disentangling the identity and medical characteristics of images and applied it to anonymise medical images [10.1109/ACCESS.2022.3157589; 10.1109/ACCESS.2021.3124844]. Our recognition by the scientific community is clear: in 2019, we published one of the most cited surveys in the field, with more than 1400 citations [10.3390/electronics8080832]. Besides a review of the current state of the research field on machine learning interpretability, it focuses on the societal impact and on the developed methods and metrics distinguished it from similar works at the time.

Classification of Ordinal Data

We have a longstanding line of research on new learning algorithms specially adapted for ordinal data and preference learning and also applicable to ranking the problem of classification with the reject option. We are one of the reference groups in the field, worldwide. We were the first to objectively define the concept of ordinal classification (until then always presented in a qualitative way) and use it to propose new ordinal classification methods. We were the first to develop a non-parametric method for unimodal distributions and use it to build better ordinal data classifiers. More recently, we have focused on ordinal segmentation for ordinal data classifiers. Dozens of publications can be found [10.1007/978-3-031-43078-7_43; 10.7717/peerj-cs.457; 10.7717/peerj-cs.457; 10.1109/ICCVW54120.2021.00079; 10.1109/IJCNN.2018.8489527; 10.5555/1314498.1314546], totalling more than 1000 citations.

12.2 AI - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Artificial Intelligence Scientific Domain is tackling complex challenges in artificial intelligence, focusing on natural language processing, computer vision, deep learning, and AI ethics. The goal of INESCTEC is to push the boundaries of AI's capabilities and enhance its integration with human society by pioneering novel applications and technologies.

A primary challenge is developing valuable and reusable AI resources, which involves creating and refining algorithms that can handle diverse inputs and produce models that are accessible and useful across various domains. The team emphasises the importance of data as a crucial asset and the need for effective data management, augmentation, and artificial data creation to overcome data scarcity.

Another notable challenge involves harnessing models and algorithms for complex tasks, creatively utilising pre-trained models, and delving into the possibilities offered by symbolic and neuro-symbolic approaches, with successful implementations showcasing the transformative impact of these strategies. These efforts aim to enhance the predictive capabilities of AI systems and enable their application in new domains.

The Scientific Domain is dedicated to enhancing the transparency and comprehensibility of AI models for humans, through the development of collaborative methods, ensuring the reliability and explainability of AI systems, and

employing visualisation tools that simplify the examination of AI algorithms and models, with documented cases illustrating the benefits of these initiatives. The team also addresses the societal impacts of AI, including privacy and safety.

INESC TEC is exploring data-economic approaches to AI development, recognising the need for new algorithms and frameworks that operate efficiently with less data. The aim is to develop intelligent decision support systems that integrate audio-visual data with other sources to improve the analysis and decision-making process in complex environments.

12.1 BIO - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Bioengenharia

12.1.3 Name of the Research Group in English

Maximum 100 characters

Bioengineering

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.

Each keyword must be up to 50 characters long.

Neuroengineering

Medical Image Computing

Biomedical Sensors

Biosignal Processing

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Coherent Concept-based Explanations in Medical Image and Its Application to Skin Lesion Diagnosis

A strategy that can enforce the visual coherence of concept activations without requiring supervision of the concept location masks, avoiding the need to obtain these annotations from experts, was proposed. Specifically, a coherence loss term and a pre-processing strategy are proposed to guide the activations of concept filters towards the locations where to which the concept is visually related to. Experiments on skin image datasets demonstrate that our method outperforms existing black-box and concept-based models for skin lesion classification [10.1109/CVPRW59228.2023.00394].

Probabilistic Interpretable Comparison Score for Optimal Matching Confidence in Single- and Multi-Biometric Face Recognition

A probabilistic interpretable comparison (PIC) score that accurately reflects the probability that the score originates from samples of the same identity is proposed. Additionally, the PIC score provides a natural way of combining several comparisons from multiple samples originated from the same network without losing its probabilistic interpretability. The experiments were conducted on five state-of-the-art face recognition systems (FRS) and four publicly available datasets. Comparing the proposed approach against all available biometric confidence estimation methods, the results demonstrate that PIC results in much more accurate, stable, and interpretable confidence estimates. [10.1109/CVPRW59228.2023.00109].

Explainable AI methods for medical imaging analysis

Development of explainable AI methods supporting clinical professionals from screening to daily clinical practice, with a special focus on decision support systems relying on imaging data. The research developed was mainly on four topics: 1) self-explanatory AI-based decisions that minimise bias, act ethically in their context and enhance trust of the end-users; 2) customisable multimodal and privacy-preserving explanations, that adapt to who will consume them; 3) quantitative methods to objectively evaluate and compare the suitability of different types of explanations for specific use cases; and 4) new strategies for presenting human understandable explanation. Uses cases were AI tools applied to colposcopy and chest X-Ray images. Publications associated to this contribution are: [10.1109/ACCESS.2021.3124844, 10.1038/s41598-022-10568-3; 10.1016/j.cmpb.2023.107558].

12.2 BIO - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Bioengineering Scientific Domain aims to promote scientific knowledge in bioengineering through fundamental and practical research, advanced training, and innovation, such as developing innovative biosensors and novel cancer image analysis approaches. Bioengineering, a rapidly growing and evolving scientific domain at the intersection of engineering and the life sciences, integrates fundamental engineering principles, practices, and technologies in medicine, biology, and environmental and health sciences to provide practical solutions to problems in these fields.

The INESC TEC team concentrates on developing mathematical theories and models, applying physical, biological, and chemical principles, creating computational models and algorithms, and designing devices and systems for applications in clinical, industrial, and educational settings. The team comprises highly multidisciplinary researchers and students with expertise spanning engineering, life sciences, mathematics, and other relevant fields. prioritising the subsequent research challenges:

- 1) Design and development of novel biosensors for macro-to-nano life sciences environments, such as wearables and snap-to-skin biosensing solutions, implantable sensors and actuators/stimulators for adaptive modulation, cell and sub-cell activity sensing in different disease models, or environmental hazardous volatile components.
- 2) Innovative approaches include cancer image analysis, cardiac image and signal analysis, as well as analysis of brain, eye, and lung images, showcasing the team's diverse contributions to medical imaging.
- 3) Innovative approaches in biorobotics and human-machine symbiosis contribute to the development of surgery, automation in molecular biology, biological-inspired robots and exoskeletons, fusion of robots with humans,

ensuring privacy in biometric algorithms, advancing data analysis methods, and designing interpretable representations.

12.1 COM - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Comunicações

12.1.3 Name of the Research Group in English

Maximum 100 characters

Communications

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.

Each keyword must be up to 50 characters long.

Communications Technologies

Mobile Communications

Intelligent Communications Systems

Internet of Things

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Breakthroughs in ultra-wideband, mmWave, and sub-THz technologies

This contribution is related to advances in ultra-high-frequency communication systems, focusing on the development of innovative transceiver architectures, photonic-based signal processing, and antenna design. At the core of these advancements is 1) the impulse-radio integration-and-fire transceiver [10.1016/j.aeue.2019.152896], a novel architecture that redefines low-power communications by leveraging impulse-radio ultra-wideband technology, 2) the optical modulation of a 79GHz resonant-tunneling diode [10.1364/OE.27.016791], which represented a groundbreaking experimental achievement, paving the way for mmWave frequency range applications, and 3) the method for designing a 300 GHz planar antenna on III-V substrates [10.1201/9781003001140-14], which illustrates our forefront position in antenna technology, enabling wide scanning angles and high efficiency for sub-THz transceivers.

Enabling wireless network digital twins using trace and machine learning driven simulations

This contribution consists of significant advancements in the simulation and modelling of wireless communications networks, leveraging new trace-driven [10.1109/WiMOB.2019.8923120] and machine learning based ns-3 simulation models [10.1145/3532577.3532607; 10.1145/3592149.3592150], for achieving custom-tailored propagation loss

models. These innovations enable the precise replication of real-world experiments, the creation of digital twins for wireless networks, and the efficient evaluation of wireless communications solutions. By incorporating real-world data such as signal-to-noise ratios, physical data rates, and channel occupancy, these models and platforms provide a foundation for the development, testing, and optimization of communication technologies in both terrestrial and non-terrestrial environments. The development of new trace-driven and machine learning based ns-3 simulation models represented a leap forward in wireless networking research and evaluation.

Revolution in antenna technology with compact designs and enhanced performance

The contribution is the advancement and optimization of antenna design for compact and efficient wireless communication systems. This is highlighted through the development of innovative methodologies and designs that enhance the performance and integration of antennas in Bluetooth Low Energy (BLE) applications and beam-scanning systems. Through the experimental validation of a novel design methodology, INESC TEC successfully demonstrated a miniaturized inductively loaded meander-line monopole antenna optimized for BLE applications [10.1109/IMOC43827.2019.9317657]. A novel antenna array design method, demonstrated at 12.5 GHz, represented another significant leap in beam-scanning technology [10.1109/MCOM.001.2100527] by enabling a 25% reduction in the number of phase shifters required for a beam-scanning reflect-array.

12.2 COM - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Communications Scientific Domain is at the forefront of developing cutting-edge wireless communications technologies central to pioneering next-generation communication systems. INESC TEC aims to advance communications research across various sectors, including industry, energy, smart cities, mobility, health, the maritime domain, and agriculture. The team focuses on developing advanced communications solutions that meet the evolving demands of these fields.

The forthcoming wave of mobile and wireless communications will revolutionise the landscape through ubiquitous multimodal sensing and localisation, service-oriented software architectures, the deployment of autonomous systems, including drones and high-altitude platforms, pervasive artificial intelligence, and the integration of edge and cloud computing. These technologies are key to facilitating on-demand virtual and physical networks, thus enabling a seamless, interconnected world.

The team is driven by the dual goals of addressing the need for bandwidth-intensive and latency-sensitive applications and bridging the connectivity gap for the unconnected, whether machines or humans. The primary challenge is the development of communications systems that are inherently context-aware and can be deployed on demand in both terrestrial and non-terrestrial settings. This entails systems capable of dynamically adjusting their operations to suit the communication context, factoring in aspects such as the environment, energy limitations, the entities involved, and the specific requirements of the users or machines.

The team aims to contribute significantly to the research and development landscape in wireless communications, pushing the boundaries of what is currently possible. We anticipate that the work will profoundly influence the creation of innovative solutions essential for the progress of various industries, guaranteeing that communication systems will be more adaptable, efficient, and scalable.

12.1 CSE - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Ciência e Engenharia dos Computadores

12.1.3 Name of the Research Group in English

Maximum 100 characters

Computer Science and Engineering

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.

Each keyword must be up to 50 characters long.

Human-Computer Interaction

Software Engineering

Data Science

Parallel and Distributed Systems

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Formally Verified Post-Quantum Cryptography

The upcoming NIST standards specify three post-quantum algorithms: ML-KEM public-key encryption and the public-key signatures ML-DSA and SLH-DSA. All emerging post-quantum standards require more computational, bandwidth, and storage resources than their classical counterparts. Their adoption will bring significant challenges for developers. INESC TEC researchers co-founded Formosa Crypto, which develops formal verification tools for cryptography. These include the EasyCrypt interactive theorem prover and Jasmin, a verification-friendly pre-assembly language. Within Formosa Crypto, INESC TEC is also co-developing libjade: a high-assurance post-quantum software library that will offer drop-in replacements for unverified assembly, matching performance, and offering security against timing attacks. The INESC TEC team has participated in a large effort that demonstrates the relevance of applying formal verification to the upcoming standards. We used EasyCrypt to formally verify the security proofs of all three algorithms [<https://ia.cr/2023/408>] and uncovered a fixable bug [<https://ia.cr/2023/246>]. We have also completed verified assembly implementations of ML-KEM, which are publicly available at [<https://ia.cr/2023/215>].

Next-Generation Storage Systems for Data-Intensive Applications

Our work has introduced novel methodologies and techniques that redefine the operational principles of storage systems, making them more efficient and performant when supporting data-intensive applications [DOI:10.1145/3385896]. These advances facilitate the seamless design and implementation of intricate storage

optimisations, being directly and transparently applicable across applications deployed in cloud computing and high-performance computing infrastructures [www.usenix.org/conference/fast22]. We have addressed persistent challenges in HPC storage systems, ensuring QoS, promoting equitable utilisation of all storage resources [10.1109/CCGrid57682.2023.00015], and speeding up complex AI training workloads [10.1109/CCGrid54584.2022.00011]. TACC, AIST, and MACC have expressed interest in incorporating our research findings into their computing infrastructures.

Pattern Discovery in Complex Networks

Advances in subgraph pattern discovery in complex networks, include the creation of a comprehensive survey with associated taxonomy, multiple contributions towards efficient and scalable algorithms, and fundamental contributions on how to extend the concepts towards richer models, including features such as direction, weights, colours, temporal and spatial information, or higher order interactions such as hypergraphs. This contribution is the outcome of over a decade of theoretical and systems research, yielding a comprehensive stream of interdisciplinary publications, ten of which are in the reporting period, e.g., [10.1371/journal.pone.0205497; 10.1007/978-3-030-40943-2_1; 10.1007/978-3-031-21131-7_44].

12.2 CSE - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Computer Science and Engineering Scientific Domain focuses on addressing the multifaceted challenges of the digital transformation era. Its mission is to address the complexity, scalability, and performance demands of modern computer and software systems, with a focus on ensuring their trustworthiness, security, and sustainability.

The Scientific Domain's research concentrates on improving the capacity to effectively handle, process, and analyse large amounts of data by leveraging digital sensing, instrumentation, and computing power. Acknowledging the increasing reliance on dependable, efficient, and ethically sound information systems, the team emphasises the need to progress software development ecosystems, ensure software correctness, validation, and testing, and place a fresh focus on ethical issues.

To achieve the necessary scalability, interoperability, and efficiency of critical information systems, the team also recognises the challenges posed by the increasing complexity of computing pipelines, advocating for extensive research in computing architectures and non-functional aspects of software.

A core aspect of the Scientific Domain's vision is to foster a symbiotic relationship between humans and machines by introducing innovative interaction paradigms like integrated multimodal systems, advanced AI tools, immersive virtual reality experiences, and user-friendly interfaces.

The Scientific Domain's research and development activities extend across diverse application domains with the goal of advancing technological frontiers and generating socio-economic impact. This involves collaborating on research projects with multiple partners and engaging policymakers to promote the adoption of research outcomes in shaping transformative public policies.

12.1 PHT - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Fotónica

12.1.3 Name of the Research Group in English

Maximum 100 characters

Photonics

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.

Each keyword must be up to 50 characters long.

Optical Sensors

Optical Fibers

Microfabrication

Quantum Simulations

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Ultra-high sensitivity with Optical Vernier Effect

By combining the signals of two interferometers with slightly detuned interference frequencies, one can achieve ultra-high enhancements of the sensitivity of interferometric sensors in what is called the optical vernier effect. Exploring fibre-based configurations, the team has recently attained significant scientific achievements, with world-record results in refractometric sensitivity [10.1038/s41598-020-76324-7] and innovative tools involving higher-harmonics and multimodal interference, most synthesised in review [10.1002/lpor.202000588]. The impact of the activity strengthened international collaborations (e.g. Leibniz IPHT) and paved for cutting-edge science and technology such as nano-Kelvin temperature sensing for the space industry.

Specialised sensors functionalised with chemical and biological receptors for active monitoring of gaseous and liquid environments

Optical solutions for chemical sensing feature multiple opportunities for technological applications, from their non-invasive character to real-time monitoring and remote sensing capabilities. For real-world applications, refractometric sensors based on resonant phenomena such as surface plasmon resonance are promising solutions featuring ultra-high sensitivity and label-free designs at lower costs. Yet, warranting specificity of the refractive index in the complexity of the chemical environment is a major challenge to bridge science to technology. During the period of evaluation, it was followed a solid research line in this direction, designing new strategies for the functionalisation of planar and fibre surfaces, while also continuously improving the design of the resonant structures, with a spotlight on novel research on

sensing with Bloch Waves [10.1364/OL.481176] and customisation of plasmonic nanomaterials to operate with unprecedented sensitivity in the near-infrared.

Advances in Femtosecond micromachining for monolithic optofluidic devices

Femtosecond micromachining is a versatile tool for the fabrication of monolithic optical devices that are capable of performing optical sensing tasks while circumventing the challenges of component alignment, mechanical stability, and miniaturisation. During the period of evaluation, the team has achieved significant breakthroughs in the optimisation of fabrication processes and techniques for optofluidic devices of high-quality [10.1109/JSEN.2020.3021586]. In particular, the highlight goes to the first-time fabrication of a microdisk resonator coupled to a suspended waveguide in a microfluidic channel [10.1038/s41598-021-88682-x]. Featuring all the advantages of the monolithic fabrication, such family of structures paves for the development of robust integrated optic devices capable of operating in real-world conditions and point-of-care applications.

12.2 PHT - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Photonics Scientific Domain explores optical phenomena as a unique toolbox for cutting-edge science and technology, exploiting symbiotic S&T for a sustainable research model. Fundamental research, on the one hand, gives rise to novel sensing systems and inventive technology. On the other hand, using emerging technology to enable innovation in real-world applications, materialising the impact of science, and diversifying funding opportunities.

This generic vision is materialised in the research challenges for the next five years:

1. Developing small systems for biological and chemical sensing: committing to creating new optical solutions (from transducer mechanisms to signal processing) that can do biochemical sensing without labels or reagents, suitable for biomedical, environmental, and industrial uses that need robust and accurate sensing.
2. Photonic sensing for extreme environments: we aim to design light-based sensors that can function in harsh environments such as space and the deep sea. By combining strategies for ultra-high sensitivity, such as the Vernier Effect, and remote sensing, we are committed to developing sensor devices that can assess critical applications in real time and with durability.
3. Optical systems and devices for analogue quantum simulations: We will use nonlinear optical systems to build analogue quantum simulators and computing platforms. We are also working on a new way to overcome the problems with von Neumann architectures for quantum simulation and make it easier to connect optical information devices.

In addition to the direct impact on S&T, the team's R&D activity contributes to the development and training of a new generation of highly specialised human resources with a unique set of competencies and critical knowledge at the national level, positively impacting the organisation while also fostering the emerging industry of photonics (e.g., spin-offs).

12.1 PES - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Sistemas de Energia

12.1.3 Name of the Research Group in English

Maximum 100 characters

Power and Energy Systems

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.

Each keyword must be up to 50 characters long.

Distributed Energy Resources

Smart Grids

Electricity Markets

Multi-energy Systems

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Contributing to private/confidential data sharing in sustainable energy grids by handling time series from distributed renewable energy (RE) assets and smart meters

A privacy-preserving protocol using vertical federated learning for vector autoregressive models enhances RE predictability [10.1109/TSTE.2021.3065117; Patent pending WO/2022/090580]. In contrast to deep learning, this method prioritises interpretability, benefiting from mature research in linear additive models. It was extended to extract sensitivity indices of the low voltage grid from meter data [10.1016/j.epr.2022.108316]. Beyond privacy concerns, a no-regret auction mechanism was proposed to incentivise data sharing in RE prediction [10.1109/TSTE.2020.3009615], quantifying data's monetary value based on its contribution to a use case's objective function. This inspired others to develop privacy-robust RE prediction [10.1109/TSG.2022.3187557] and energy data monetisation algorithms [10.1016/j.epr.2022.108442].

Contributing to energy sharing at energy communities (EC)

A novel peer-to-peer (P2P) market was formulated as a post-delivery pool that automatically builds supply and demand curves from metered energies and tariffs, interacting with local flexibility and wholesale markets [10.1016/j.energy.2023.128853]. New methods proposed to coordinate P2P markets with grid management, considering local grid constraints inherently or iteratively [10.1016/j.segan.2023.101075, 10.3390/en16031143, patent-pending EP23181146.4]. This work resulted from international cooperation with DTU and the UFJF (Brazil) and inspired others to achieve mutual-benefit coordination of P2P market and distribution grids [10.1016/j.apenergy.2022.118907]. Contribution to EC operation with energy storage, with tractable model predictive control algorithm that models degradation, efficiency, and V-I. The two were validated in a regulatory sandbox of an industrial community with Capwatt [10.1109/EEM58374.2023.10161761].

Aggregation of multi-energy flexible assets for market bidding

Distributed optimisation for bidding in electricity, gas, and carbon markets by an aggregator of multi-energy flexible assets connected to electricity, heat, gas grids and ensuring secure operation without explicit knowledge of the grid constraints [10.1016/j.apenergy.2021.117460]. Inspired by this, other researchers explored the multi-energy complementarity across markets and energy infrastructures [10.1016/j.renene.2023.119406]. A stochastic optimisation approach was proposed to deal with forecast uncertainties when trading flexibility [10.1016/j.apenergy.2019.01.191], whose contributions are combining multiple sources of uncertainty (RES, consumption, human preferences) and extending the bidding to the supply and demand sides, offering multiple bidding options compared to single bidding strategies. In the EU project ATTEST, coordinated by INESC TEC, it resulted in 2 open-source tools [<https://github.com/ATTEST-project>].

12.2 PES - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Power and Energy Systems Scientific Domain envisions supporting society's full and enduring decarbonisation, adopting a multidisciplinary strategy acting across the whole energy value chain and planning and operating it across multiple energy carriers, infrastructures, and users in an integrated, interconnected, and digitalised energy ecosystem. This will be anchored on combining model-based and data-driven methods for optimising and controlling energy systems while proposing novel policy and regulatory solutions. Research outcomes include concepts, models, methodologies, and tools addressing the decision problems of citizens, communities, multi-utilities, system operators, regulators, policymakers, and government bodies, tackling four major challenges:

1. Cost-effective decarbonisation and digitalisation of energy systems: designing and optimising near-100% renewable based energy systems; facilitating secure data sharing in the energy sector (energy data spaces).
2. De-centralising energy-driven business models and markets: redesign and regulate wholesale electricity markets to coordinate with local markets, including support mechanisms such as capacity payments.
3. Resilience and reliability of energy systems: models and tools for assessing the long-term adequacy of interconnected systems under climate change and power system robustness in converter-dominated grids.
4. Smart control architectures and centres of the future: coordinated operation between electricity markets, Transmission System Operators (TSO), and Distribution System Operators (DSO); decentralised protection, automation, and control systems based on virtualisation and distributed computation at the edge; trustworthy AI solutions to support system operations.

A laboratory infrastructure for smart grids and electric vehicles enhances the research and innovation capabilities of the scientific domain by providing technological support for the development and validation of theoretical concepts.

12.1 ROB - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Robótica

12.1.3 Name of the Research Group in English

Maximum 100 characters

Robotics

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.

Each keyword must be up to 50 characters long.

Autonomous Navigation

Marine, Agro and Industrial Robotics

Localisation and Mapping

Human-Robot Collaboration

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Advanced Perception for Environment Awareness

This research has propelled the capabilities of robotic systems, particularly in addressing intricate and dynamic environments and contributing significantly to mapping and exploration applications. The outcomes include successive generations of sensing systems [10.5194/adgeo-62-1-2023; 10.1016/j.inffus.2019.07.014] and data processing algorithms [10.1007/s10846-017-0689-0; ACCESS.2020.2978406] integrated into multiple underwater robots. Noteworthy achievements encompass high-resolution imaging with millimetre precision, enabling underwater 3D environment modelling at substantial depths. The distinctive feature of this development lies in its simultaneous achievement of high-resolution imaging and mapping, as well as meaningful miniaturization [10.1016/j.inffus.2019.07.014], setting it at the edge of current solutions in the state of the art.

Collaborative assembly

The conducted research aimed to improve the natural collaboration level of a cobot during engine assembly operations by proposing a cognitive system powered by computer vision [10.1109/ICARSC58346.2023.10129597] and deep learning to interpret the operator's implicit communication cues [10.1016/j.rcim.2022.102449]. The proposed system is based on a residual CNN and a long-short-term memory RNN (ResNet-34 + LSTM), and it obtains assembly context by recognising the actions taken by the operator. The assembly context was then incorporated into a collaborative plan capable of autonomously controlling robot tasks. The proposed model showed excellent performance, achieving an accuracy of 96.65% and a temporal mean intersection over union (mIoU) of 94.11% for the action recognition of the considered assembly. Moreover, a task-oriented evaluation showed that the proposed cognitive system could leverage the performed human action recognition to command adequate robot actions with near-perfect accuracy.

NAVIBOX – Semantic mapping and localisation

Another significant contribution was the development of NAVIBOX, an innovative solution for semantic mapping and localisation. It integrates three distinct information layers - metric, topological and semantic - to achieve a reliable and robust localisation and mapping solution for outdoor applications [10.1002/rob.22140; 10.1016/j.robot.2021.103725; 10.1002/rob.22140]. Additionally, it incorporates advanced path planning and obstacle avoidance algorithms capable

of navigating irregular environments, accounting for robots with dynamic centres of mass. Furthermore, NAVIBOX features a mission supervisor capable of receiving agronomic prescription maps and decomposing them into a set of atomic robotic actions for execution. This supervisor also monitors the execution process to ensure alignment with the initial plan, enhancing overall operational efficiency and effectiveness. NAVIBOX was tested and validated in novel agronomic robots also researched and developed by INESC TEC team.

12.2 ROB - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Robotics Scientific Domain is at the forefront of developing real multi-domain robotics. It combines intelligence, autonomy, and usefulness seamlessly across various uses on land, in the air, on the water, and underwater. INESC TEC leads the way in developing new and creative scientific methods that connect different areas, resulting in a cohesive foundation for robotic systems.

The focus on advancing autonomy is central, specifically empowering robots to operate effectively in complex and dynamic environments across multiple domains. This involves creating and maintaining intricate environmental maps, reacting swiftly to unforeseen events, and enabling unattended operations over extended periods.

The increasing interaction between people and robots is equally significant in all areas. The team seeks to transform programming and communication interfaces, enhancing the simplicity and availability of assigning tasks to robots for operators from diverse backgrounds. This is essential for smooth and effective collaboration and communication, lowering risks, and enhancing security in various settings.

In each target domain, the team investigates new types of robotic action that go beyond conventional limitations. By doing so, they introduce innovative solutions tailored to the unique challenges of ground, air, water, and undersea applications, enabling them to interface with flexible objects and manipulate objects from moving platforms. This interrelated investigation pushes the limits of conventional applications in each discipline and broadens the scope of what robotics is capable of.

As robotics expands into new fields and operational scenarios, INESC TEC recognises the importance of innovative design methodologies spanning diverse environments. The goal is to streamline the deployment of robotic technologies, guaranteeing the effective and cohesive harnessing of multi-domain robotics' transformative potential across a wide range of applications.

12.1 SEM - Identification of each Research Group

12.1.1 Research Group reference

Pre-filled field.

12.1.2 Name of the Research Group in Portuguese

Maximum 100 characters

Engenharia e Gestão de Sistemas

12.1.3 Name of the Research Group in English

Maximum 100 characters

Systems Engineering and Management

12.1.4 Keyword(s)

Enter a **maximum of 4 keywords** to adequately characterise the scope of the Research Group's activity.
Each keyword must be up to 50 characters long.

Digital Transformation
Operations Management
Operations Research
Service Design

12.1.5 Existed in the period 2018-2023

YES

12.1.6 Description of up to 3 Research Group's most relevant contributions during 2018-2023 (publications are not considered in this subsection)

Describe the 3 contributions considered most relevant carried out by researchers from the Research Group included in the R&D Unit application (regardless of whether it previously existed or not) in 2018-2023. In the case of contributions that have been published, it is not intended to cite the publication, but to describe the contribution and justify why it is considered important.

Maximum 3 000 characters.

Human-guided learning of interpretable decision rules

Explainable Artificial intelligence (XAI) is a growing field, due to the difficulty to trust most AI models. INESC TEC has been exploring XAI to approach operations management problems in dynamic settings, where information is revealed gradually and decisions need to be made sequentially, often in real-time. This is the case of inventory management, dynamic scheduling, order allocation, dynamic vehicle routing and time slot management. All these problems were approached by INESC TEC with XAI methods, within the scope of European projects (e.g., TRUST-AI, PEER), and consultancy projects with real-world companies (e.g., DRIVEN with Farfetch), and resulted in several publications [e.g. 10.1016/j.omega.2022.102643; 10.1080/00207543.2019.1597293] and prototypes. Within XAI, INESC TEC has been working with (inherently explainable) symbolic expressions, which are learned by bringing human knowledge into the learning loop.

Service Design for Innovation (SDIN) and Sustainability

SDIN builds upon understanding human experience to design innovative service systems. In 2018-23 INESC TEC advanced service design methods to address servitisation in manufacturing companies and in complex service systems. These developments had key applications, namely to the design of the Portuguese Electronic Health Record. INESC TEC led a Marie Curie network in SDIN with 6 European countries, in sectors such as healthcare (Experio Lab) and energy (EDP), leading to impactful publications [e.g. 10.1177/1094670517746]. INESC TEC also expanded to the design for sustainability transformation, namely with the ECO-Service Design method [10.1016/j.jclepro.2021.127228]. Through H2020 project POCITYF, INESC TEC also contributed to understand the factors driving value co-creation and engagement with sustainable energy solutions, developing novel citizen engagement strategies, which were applied in 8 European cities.

Innovative design methods for digital twin and industrial digital platforms

Following prior research and the Transformer 4.0 (TRF4.0) project (2020-2023), INESC TEC achieved significant contributions to advance the state-of-the-art in the design and management of digital twins supported by industrial digital platforms. TRF4.0 was an MIT-Portugal flagship research project led by EFACEC (a Portuguese company operating in energy, engineering, and mobility sectors), involving a multidisciplinary team from INESC TEC, INEGI and MIT Sociotechnical Systems Research Centre. TRF4.0 developed a proof-of-concept for a digital platform, managing digital twin instances of Power Transformers and a set of tools (using machine learning and optimisation techniques) for

managing the life cycle of the Power Transformer. A Digital Twin-enabled platform powered by optimization and AI offers valuable insights into future product design and grid response prediction [10.1109/INDIN45523.2021.9557455].

12.2 SEM - Researchers from each Research Group

Cf. Annex I

12.3 Description and main contributions of each Research Group in 2025-2029

12.3.1 General description of the Research Group

Describe the Research Group indicating the scope of activities, the main objectives and aspects in which it intends to contribute to the various dimensions of R&D activities, regardless of whether the Research Group or the R&D Unit previously existed or not.

Maximum 2 000 characters.

The Systems Engineering and Management Scientific Domain bridges management and engineering to advance the design, implementation, and improvement of systems for decision support, human-centred operations, technology management and innovation. The team addresses the different activities of the systems engineering lifecycle with a focus on four research challenges:

- Understanding the role of businesses and industries in sustainable ecosystem transformation and designing technology-enabled system innovations to facilitate this transformation. How to innovate business models and management practices for sustainability, develop new technology-enabled service solutions and value propositions for ecosystem transformation, and facilitate the adoption and diffusion of their solutions?
- Reducing critical dependencies and weaknesses in current global supply chain models, managing trade-offs, enhancing synergies between sustainability and resilience practices, and using digital technologies for supply chain visibility and joint innovation activities. This area examines how digital technologies help reduce disruptions, enhance supply chain sustainability and resilience, and combine marketing and operations for improved performance.
- Modelling complex relationships among stakeholders with multiple goals, improving decision-making processes in uncertain and dynamic settings, and developing adaptable production systems. This area investigates how to include uncertainty in system modelling, improve decision-making processes, and use hybrid simulation and digital twins for effective operational management.
- Designing systems that foster trust while promoting user adoption and engagement. The main research questions revolve around designing inter-organisational information systems for collaboration and sustainability, managing industrial data to create value, and evaluating the impact of new technologies on organisational capabilities.

13 Thematic Lines

(only for R&D Units with more than 100 Integrated PhD holder Researchers, and optional for these)

This section is optional. Thematic Lines, when existing must have a minimum critical mass.

13.1 Digital Models - Identification of each Thematic Line

13.1.1 Theme Line Reference

Pre-filled field.

13.1.2 Designation of the Thematic Line in Portuguese

Maximum 100 characters.

Modelos Digitais

13.1.3 Designation of the Thematic Line in English

Maximum 100 characters.

Digital Models

13.1.4 Coordinating researcher of the Thematic Line

Select the coordinating researcher of the Thematic Line from the pre-filled list of integrated **PhD holder researchers** confirmed in the Team Registration menu (with link to CIÊNCIAVITAE and ORCID identifier).

Susana Alexandra Barbosa

13.2 Description of each Thematic Line

13.2.1 Description of the Thematic Line

Briefly describe the objective of the Thematic Line. Explain why the Thematic Line is envisaged and how the organization of Researchers or Research Groups (if any) and Thematic Lines contributes to achieving the objectives and strategy of the R&D Unit.

Maximum 3 000 characters.

This line aims to bring comprehensive, high-precision digital models of physical entities into the lab, leveraging the groundbreaking strides in pervasive intelligence, a core ethos at INESC TEC. The drive to create more complex digital twins has greatly increased, making it a priority in the EU's research agenda, with two flagship initiatives focused on developing advanced digital twins of the human brain (EBrains) and the Earth (DestinE).

Future digital twinning platforms will encompass a complete computing pipeline from sensing, edge computing, bigdata management, and processing for monitoring, analysis, training, inference, and forecasting, culminating in visualisation and actuation. A high level of maturity in digital twins leads to a seamless and interactive exchange of information between humans and digital counterparts. This will require cutting-edge technologies like cloud and high-performance computing, pushing the limits of what is possible in terms of scalability, performance, efficiency, reliability, security, and privacy.

Computer Science & Engineering and Artificial Intelligence will focus on the computational challenges of building large-scale, high-fidelity digital twins, including big data management, machine learning, human-computer interaction, information security, and advanced visualisation. The AI researcher's data-driven and symbolic AI knowledge will make the twins robust and explainable. Communications will enable bandwidth-intensive, latency-sensitive, and secure data transmission.

Robotics will focus on dynamic and autonomous sensing, cyber-physical models and integrating autonomous robots in areas shared with humans. Bioengineering will develop macro to nano biosensors as inputs to biological or "bio-inspired" models, enabling early disease detection, diagnosis, and prediction. Photonics will innovate in real-time nano-scale diagnosis and long-term sensing of extreme environments.

Power & Energy Systems researchers will model and optimise integrated energy systems. In contrast, in Systems Engineering and Management will optimise complex organisations, design customer-centric services, and manage technology-based innovation.

This line presents extensive opportunities to impact INESC TEC's core innovation areas:

- Industry: Optimising operations, maintenance, and safety;
- Healthcare: Revolutionising patient care through organ/individual simulation and adverse event prediction;
- Environment and Climate: Capturing and predicting weather, climate, ecosystems, and biodiversity for emergency response.

This multidisciplinary thematic line will strategically leverage and integrate INESC TEC's diverse research capabilities to realise the groundbreaking potential of complex digital models and twins. It calls for further collaborative research to enable more accurate, dynamic digital models that can optimise operations, improve maintenance, enhance safety, revolutionise patient care, and predict and respond to emergencies.

13.3 Research Groups that contribute to each Thematic Line

Artificial Intelligence
Bioengineering
Communications
Computer Science and Engineering
Photonics
Power and Energy Systems
Robotics
Systems Engineering and Management

13.1 Sustainable Transformation - Identification of each Thematic Line

13.1.1 Theme Line Reference

Pre-filled field.

13.1.2 Designation of the Thematic Line in Portuguese

Maximum 100 characters.

Transformação Sustentável

13.1.3 Designation of the Thematic Line in English

Maximum 100 characters.

Sustainable Transformation

13.1.4 Coordinating researcher of the Thematic Line

*Select the coordinating researcher of the Thematic Line from the pre-filled list of integrated **PhD holder researchers** confirmed in the Team Registration menu (with link to CIÊNCIAVITAE and ORCID identifier).*

Clara Sofia Teixeira Gouveia Moura

13.2 Sustainable Transformation - Description of each Thematic Line

13.2.1 Description of the Thematic Line

Briefly describe the objective of the Thematic Line. Explain why the Thematic Line is envisaged and how the organization of Researchers or Research Groups (if any) and Thematic Lines contributes to achieving the objectives and strategy of the R&D Unit.

Maximum 3 000 characters.

This thematic research line aims to harness interdisciplinary expertise to address the critical challenge of achieving long-term sustainability in social, economic, and environmental systems. It leverages the collective strengths of INESC TEC's Scientific Domains to create innovative solutions that balance the intricate interplay of competing objectives within each problem space.

As we navigate the complexities of integrating technology with natural and social systems, this thematic line prioritises the reduction of resource consumption and waste generation through reuse, while exploring sustainable economic models.

Artificial Intelligence and Computer Science & Engineering will develop algorithms and computational models that optimise resource efficiency and reduce environmental impact and can support AI-driven energy and transport management systems.

Bioengineering will contribute by advancing technologies for sustainable healthcare, including the development of biodegradable materials and energy-efficient medical devices. This domain will also explore bioengineering solutions to environmental challenges, such as bioremediation techniques for pollution cleanup.

Communications will work on enhancing the energy efficiency of digital networks, which is crucial for reducing the carbon footprint of our increasingly connected world. This includes the development of low-power communication protocols and the optimisation of data transmission for energy savings.

Photonics will innovate in the development of precision sensing, energy-efficient lighting and photovoltaic technologies, contributing to the reduction of energy consumption and the advancement of renewable energy sources.

Power and Energy Systems will lead efforts in modelling and optimising integrated, sustainable energy systems. Their work will focus on the massive integration of renewable energy sources, energy storage solutions, and the electrification of transport and industry.

Robotics will develop autonomous systems for environmental monitoring and conservation, including robots capable of planting trees, cleaning oceans, and monitoring wildlife. These robots will operate with minimal human intervention, reducing the ecological footprint of conservation efforts.

Systems Engineering and Management will tackle the challenge of designing sustainable business models and optimising complex organisational networks for environmental sustainability. This includes the development of decision-support systems for sustainable supply chain management and the integration of circular economy principles into business practices.

This thematic line strives to foster a collaborative approach among all INESC TEC researchers to enhance and bolster the sustainability of the developed technology by lowering its adoption, maintenance, social, economic and environmental costs.

13.3 Research Groups that contribute to each Thematic Line

Artificial Intelligence

Bioengineering

Communications

Computer Science and Engineering

Photonics

Power and Energy Systems

Robotics

Systems Engineering and Management

13.1 Tackling the Extreme - Identification of each Thematic Line

13.1.1 Theme Line Reference

Pre-filled field.

13.1.2 Designation of the Thematic Line in Portuguese

Maximum 100 characters.

Enfrentar Desafios Extremos

13.1.3 Designation of the Thematic Line in English

Maximum 100 characters.

Tackling the Extreme

13.1.4 Coordinating researcher of the Thematic Line

*Select the coordinating researcher of the Thematic Line from the pre-filled list of integrated **PhD holder researchers** confirmed in the Team Registration menu (with link to CIÊNCIAVITAE and ORCID identifier).*

Eduardo Alexandre Pereira da Silva

13.2 Description of each Thematic Line

13.2.1 Description of the Thematic Line

Briefly describe the objective of the Thematic Line. Explain why the Thematic Line is envisaged and how the organization of Researchers or Research Groups (if any) and Thematic Lines contributes to achieving the objectives and strategy of the R&D Unit.

Maximum 3 000 characters.

This line aims to address the challenges posed by extreme assumptions and design spaces that are increasingly prevalent due to the distributed, intelligent, and autonomous nature of modern digital technologies. This initiative recognises the diverse forms extremes can take, including uncooperative or hostile environments, high-risk activities, instantaneous decision-making requirements, and the handling of massive datasets or entities. A key challenge in these extreme scenarios is the difficulty of conducting proper experimentation and testing, often due to accessibility risks, costs, legal and ethical constraints, or the hypothetical nature of the scenarios.

INESC TEC's interdisciplinary expertise will develop novel design methods and tools aimed at delivering solutions that are trustworthy, robust, and capable of self-adaptation in the face of extreme conditions. This will involve the use of synthetic modelling techniques and the creation of comprehensive virtual environments to simulate and analyse extreme scenarios safely and effectively.

Computer Science & Engineering and Artificial Intelligence will focus on creating advanced algorithms and computational models capable of operating under extreme conditions. This includes the development of AI systems for rapid decision-making and the analysis of vast datasets.

Communications will concentrate on ensuring reliable and secure data transmission in extreme environments, developing technologies that can withstand interference, disruptions, and high-risk conditions, thereby maintaining the integrity and availability of critical communications.

Photonics will develop sensors and imaging technologies capable of operating in extreme conditions, such as high temperatures, pressures, or radiation levels, enabling the observation and analysis of otherwise inaccessible or hazardous environments.

Robotics will focus on designing and deploying autonomous systems capable of navigating and performing tasks in dangerous or uncooperative environments, from deep-sea exploration to disaster response, minimising human exposure to risk. Similarly, Bioengineering will explore the development of resilient biotechnologies for human monitoring extreme conditions, as well as bio-sensing techniques that can operate in hostile or contaminated environments, contributing to environmental monitoring and cleanup efforts.

Power & Energy Systems will address the challenges of energy management and distribution in extreme scenarios, focusing on developing resilient and adaptive energy systems that can ensure continuous operation under adverse conditions.

Systems Engineering and Management will tackle developing decision-support tools and methodologies for planning and executing high-risk and high-stakes activities.

Through this initiative, INESC TEC reaffirms its commitment to pushing the boundaries of innovation, contributing to a future where extreme environments are no longer barriers to exploration, discovery, and progress.

13.3 Research Groups that contribute to each Thematic Line

Artificial Intelligence

Bioengineering

Communications

Computer Science and Engineering

Photonics

Power and Energy Systems

Robotics

Systems Engineering and Management

13.1 Trustworthy Technology - Identification of each Thematic Line

13.1.1 Theme Line Reference

Pre-filled field.

13.1.2 Designation of the Thematic Line in Portuguese

Maximum 100 characters.

Tecnologia Confiável

13.1.3 Designation of the Thematic Line in English

Maximum 100 characters.

Trustworthy Technology

13.1.4 Coordinating researcher of the Thematic Line

Select the coordinating researcher of the Thematic Line from the pre-filled list of integrated **PhD holder researchers** confirmed in the Team Registration menu (with link to CIÊNCIAVITAE and ORCID identifier).

Rui Oliveira

13.2 Description of each Thematic Line

13.2.1 Description of the Thematic Line

Briefly describe the objective of the Thematic Line. Explain why the Thematic Line is envisaged and how the organization of Researchers or Research Groups (if any) and Thematic Lines contributes to achieving the objectives and strategy of the R&D Unit.

Maximum 3 000 characters.

This line aims to develop reliable, secure, and ethical digital technologies integral to modern society. This multidisciplinary strand leverages expertise from the eight INESC TEC Scientific Domains to address the challenges of creating technology that is not only advanced but also dependable and aligned with societal and environmental values.

As the world faces pressing challenges such as climate change, inequality, and geopolitical instability, trustworthy technology will become increasingly important in supporting sustainable and resilient societies. Transparency, equity, reliability, security, privacy, and meaningful human control need to be at the forefront of research and development in the upcoming years as our dependence on cutting-edge technologies increases.

Artificial Intelligence and Bioengineering will develop explainable AI models, ensuring fairness in algorithmic decision-making, enhancing robustness against biased or unethical outcomes, and, chiefly, for healthcare, developing transparent and replicable machine learning models for patient benefit.

Computer Science and Engineering will lead the research on the dependability-, security-, and privacy-enabled technologies orchestrating the various Scientific Domains concerns and expertise, notably on large-scale data-centric systems, towards robust digital and cyber-physical real-world solutions. Communications and Photonics will work on secure data transmission, protecting sensitive information, and defending against adversarial attacks.

Robotics and Computer Science & Engineering will explore human-computer interaction, designing intuitive and trustworthy communication channels for seamless collaboration between humans and autonomous systems.

Power & Energy Systems will leverage its expertise and long-standing experience in developing secure and efficient power grids to ensure data integrity and trustworthiness in decentralised autonomous system operations, as well as to promote cross-disciplinary translational research into related critical infrastructures.

Systems Engineering and Management will optimise complex organisations and networks, ensuring customer-centric service design, and managing technology-based innovation.

By encouraging collaboration among these diverse research groups, the thematic research line will create synergies that drive innovation in trustworthy technology. This multidisciplinary approach will enable the development of

comprehensive solutions that address the technical, ethical, and societal challenges associated with the increasing reliance on digital systems.

The research line will also prioritise disseminating knowledge and best practices, engaging with stakeholders across academia, industry, and government to promote adopting trustworthy technology. Through this collaborative effort, the thematic research line aims to contribute to a future where digital systems are reliable, secure, and aligned with the values and needs of the communities they serve.

13.3 Research Groups that contribute to each Thematic Line

Artificial Intelligence

Bioengineering

Communications

Computer Science and Engineering

Photonics

Power and Energy Systems

Robotics

Systems Engineering and Management

14 Ethical issues

14.1 Ethical Issues (optional field)

Describe the ethical issues related to the planned activity, or the use of results from the R&D Unit's activity, and indicate how these issues will be addressed. Please consider the Ethics Self-assessment Guide available in the call documents section.

Maximum 6 000 characters.

In 2019 INESC TEC started a process to develop its own Code of Ethics, for which a special group was created and presented a proposal. Several written opinions were collected, and public discussion sessions took place, leading to a final text approved by the General Council in April 2021.

The approved Code of Ethics (bit.ly/49yyTTI) establishes a set of principles and a code of conduct that should guide the institutional and individual activities at INESC TEC, namely in what concerns R&D. It indicates specific procedures for the ethical assessment and clearance of R&D projects, comprising a whole section dedicated to the development and use of Artificial Intelligence (AI) systems.

This Code of Ethics, together with the documents that frame INESC TEC Social Responsibility, Conflict of Interest Management, and Data Protection Policies, constitute a cornerstone of the institution's vision and position, supporting all its activity.

As stipulated in the Code of Ethics, a five member Ethics Committee (EC) was nominated by the Board, integrating INESC TEC's researchers from different areas, as well as a data protection specialist and an external member holding a PhD in ethics in research. The EC had its first meeting in March 2022.

By 2018, INESC TEC had already designated a Data Protection Officer (DPO) and established a number of procedures in order to monitor compliance with data protection legal requirements, including a specific procedure to assess and follow up R&D projects, implementing a "data protection by design and by default" approach.

Hence, any project, thesis or dissertation dealing with humans or personal data, and AI or autonomous systems, should answer an ethics questionnaire and submit it to the EC, both at the submission time and upon approval, for a more thorough analysis. A similar procedure is due for the project evaluation by the DPO as for data protection, often leading to the performance of specific data protection impact assessments.

If the project involves human participation, an informed consent done in accordance with sound ethical principles and data protection legislation, for which a template is provided, has to be given and submitted to the analysis of the EC.

Should a written opinion of the EC be required, for project submission or for the publication of results, there is also a template that researchers should use.

The EC site on intranet provides information on ethical issues, and official or informal papers concerning ethical matters. The EC has also promoted discussion sessions concerning special interest topics, meeting the training and awareness needs of researchers. In this regard, INESC TEC researchers have been invited to attend courses or conferences on research ethics and integrity, involving experts in the field. Finally, a digital platform that supports all the interactions between the researchers and the EC or the DPO is provided, where all the referred documents and templates can be found.

Considering INESC TEC's main areas of research, Ethical, Legal, and Social Issues are mostly related with the recruitment and voluntary participation of human subjects, the processing of personal data or other kind of sensitive information and the design of AI or autonomous systems. Some specific technologies and areas of application, such as bioengineering, health, education, justice and law enforcement, critical infrastructures management, profiling, tracking, monitoring and biometric identification systems, or technologies which may fall under the category of dual use, typically raise more serious concerns and demand special attention and monitoring.

INESC TEC is not typically involved in research dealing with human embryos/foetus, human cells or tissues, or animals. While it may occasionally participate in medical studies or even clinical trials, namely in the bioengineering domain, those studies are promoted and led by external partners, healthcare entities or medical research institutes, whose ethical assessment is also mandatory.

Most of INESC TEC international scientific collaborations are with entities from EU countries or countries with EU association agreements (or being covered by EC adequacy decisions in what concerns data transfer regimes). However, when INESC TEC engages with external partners from other foreign countries, it makes sure that no double ethical standards are applied to such collaborations.

INESC TEC is also deeply engaged in the promotion of open science best practices and goals, aiming at maximising the reuse and dissemination of R&D results. In this regard INESC TEC supports open access of scientific publications, with a total of 2359 Full Open Access publications, indexed in Scopus, between 2018 and 2023 INESC TEC was also an early adopter of the FAIR principles and maintains its own institutional data repository, counting a total of 142 publicly available datasets by the end of 2023. In addition, INESC TEC has a dedicated team, including a PhD data steward, raising institutional FAIR data awareness and providing expert support in the development of Data Management Plans. Finally, when an opinion is requested from the EC, the forms to be submitted with the study protocol provide concrete questions about the measures implemented or designed to meet open science goals.

Last, but not least, INESC TEC has in place a Diversity and Inclusion (D&I) Programme, having gender equality as a priority - the Gender Equality Plan entered into force in July 2022 -, but also addressing interculturality and accessibility as main areas of concern and action. Beyond promoting equality of opportunities, diversity in research relates to research teams' composition and to the object of research itself as a factor of excellence. In fact, as scientific progress relies on problem solving and collaboration, research teams composed of people with diverse experiences and areas of expertise tend to be more creative and innovative.

15 Aspects of the Activity Plan that involve requesting Programmatic Funding

Information uploaded on the platform

16 Funding planned for 2025-2029 for evaluation purposes.

*Completing the tables in the Application Form for the expected funding of the R&D Unit and for the expenditure budget of the R&D Unit in each Management Institution is mandatory. This information is considered part of the assessment of the adequacy of objectives, strategy, activity plan and organization of the R&D Unit for 2025-2029. Information concerning FCT funding does **not include amounts corresponding to Base or Programmatic Funding that may be granted by FCT, I.P. following the assessment** (for assessment purposes, the information to be considered for these components is the one provided in the previous section of the Application Form). All other sources (e.g. projects, grants or research contracts) should be considered. R&D Units obtaining an overall rating of "Excellent", "Very Good" or "Good"*

in the evaluation will have to complete, prior to signing the respective terms of acceptance, budgets relating to all sources of funding, including the Base or Programmatic Funding that is allocated following the evaluation.

The budget in each Management Institution for “Adaptation of buildings and facilities” to be ascribed to the Base or Programmatic Funding that may be attributed by FCT, I.P. following the evaluation, cannot exceed 10% of the total funding.

The budget of each Management Institution for “General charges” (including Overheads) to be allocated to the funding that may be attributed by FCT, I.P. following the evaluation is a fixed amount of 25% of the corresponding Base Funding. The total budget of the R&D Unit for 2025-2029 is the sum of the budgets in the Principal Management Institution and other Management Institutions, if any.

16.1 Expected funding of the R&D Unit for 2025-2029

*Fill in the table (in thousands of euros). **Do not include amounts corresponding to Base or Programmatic Funding to be allocated by FCT after the present evaluation exercise.** The annual amounts of all other planned funding, from any source, national or international, relating to activities in which integrated PhD holder researchers from the R&D Unit will be involved and related to expenses covered directly by funding obtained by the R&D Unit must be recorded. Do not include amounts corresponding to permanent salary expenses for teachers and researchers, facilities, utilities, etc. that are ensured by the Participating or Management Institutions (or other entities) regardless of the funding obtained directly by the R&D Unit. The values recorded in the table will be taken into account for monitoring purposes, namely in the analysis of the progress and final reports planned for R&D Units that will be financed following the evaluation.*

FUNDING SOURCES (TOTAL FUNDING)	2025	2026	2027	2028	2029	TOTAL (K€)
Fundação para a Ciência e a Tecnologia, I.P. - FCT	5 129	5 480	5 860	6 271	6 716	29 456
Project funding expected to be received	1 729	1 815	1 906	2 001	2 101	9 552
Expected funding for contracts of researchers with PhD (1)	900	945	992	1 042	1 094	4 973
Expected funding for PhD, PostDoc or other fellowships (2)	2 200	2 420	2 662	2 928	3 221	13 431
Audit certificates						0
Other funding	300	300	300	300	300	1 500
Other national sources	20 000	17 150	5 980	6 574	7 475	57 179
Funding expected to be received from Participant or Management Institutions						0
Public sources (3)	18 000	15 000	3 500	3 500	3 500	43 500
Companies, industry and other private sources based in Portugal (3)	1 500	1 650	1 980	2 574	3 475	11 179
Any other funding source (3)	500	500	500	500	500	2 500
International sources	10 950	11 995	13 145	14 409	15 800	66 298
European Commission (3)	10 100	11 110	12 221	13 443	14 787	61 662
Companies, industry and other private sources not based in Portugal (3)	350	385	424	466	512	2 137
Other funding sources (3)	500	500	500	500	500	2 500
TOTAL	36 079	34 625	24 985	27 254	29 991	152 933

16.2 Expenditure budget of the R&D Unit at the Main Management Institution

Fill in the table (in thousands of euros). Do not include expenses corresponding to Base or Programmatic Funding to be allocated by FCT after the present evaluation exercise. This budget table must correspond to the annual application of all other expected funding relating to activities in which Integrated Researchers from the R&D Unit are involved and must correspond to expenses covered directly by the funding obtained by the R&D Unit. Do not include amounts corresponding to permanent salary expenses for teachers and researchers, facilities, utilities, etc. that are ensured by the Participating or Management Institutions (or other entities) regardless of the financing obtained directly by the R&D Unit.

EXPENSE BUDGET ITEMS	2025	2026	2027	2028	2029	TOTAL (K€)
Human Resources	23 429	22 057	15 789	17 066	18 584	96 925
Contracts of researchers with PhD	5 625	5 100	3 600	3 780	3 969	22 074
PhD, PostDoc or other fellowships	4 400	4 224	3 041	3 315	3 646	18 627
Contracts of technical or secretarial staff	13 404	12 733	9 148	9 971	10 968	56 225
Missions	2 000	1 920	1 382	1 507	1 657	8 467
Visiting researchers or consultants	300	300	300	330	363	1 593
Patents registration and maintenance	150	165	182	200	220	916
Service or product procurement and acquisition	4 900	5 095	3 668	4 158	4 775	22 596
Equipment	3 000	2 880	2 074	2 260	2 486	12 700
Adaptation of facilities and buildings	300	288	207	226	249	1 270
Audit certificates			0	0	0	0
Other expenses	2 000	1 920	1 382	1 507	1 657	8 467
TOTAL	36 079	34 625	24 985	27 254	29 991	152 933

16.3 Expenditure budget of the R&D Unit in other Management Institutions (if any)

For each of the Management Institutions, complete the corresponding table in the Application Form, analogously to that described for the Main Management Institution.

16.4 Estimate of the percentage distribution by types of expenditure to be ensured with Base Funding for 2025-2029 that will be obtained following the evaluation

Fill in the table with estimates of the percentage breakdown by expense categories to be ensured with Base Funding that will be attributed by FCT.

The budget in each Management Institution for “Adaptation of buildings and facilities” to be assigned to the Base Financing by FCT cannot exceed 10% of this total funding.

The budget of each Management Institution for “General charges” (including Overheads) to be allocated to the funding that will be attributed by FCT is a fixed amount of 25% of the direct expenses of the corresponding Base Financing.

EXPENSE BUDGET ITEMS	%
Human Resources	30%
Contracts of researchers with PhD	15%
PhD, PostDoc or other fellowships	10%
Contracts of technical or secretarial staff	5%
Missions	5%
Visiting researchers or consultants	5%
Patents registration and maintenance	5%
Service or product procurement and acquisition	7%
Equipment	15%
Adaptation of facilities and buildings	8%
Audit certificates	
Other expenses	25%
TOTAL	100%

17 Budget justification for 2025-2029

Information uploaded on the platform

18 Members of the future External Advisory Board

(mandatory field for all R&D Units)

Complete the table in the Application Form with the composition of the External Advisory Board of the R&D Unit in the immediate future.

For each member of the Board, indicate name, affiliation, and country of the affiliation.

Name of the R&D Unit	Member Name	Institution	Country
INESC TEC	José Fortes	University of Florida	USA
INESC TEC	Anne-Marie Kermarrec	EPFL - L'Ecole Polytechnique Fédérale de Lausanne	Switzerland

Name of the R&D Unit	Member Name	Institution	Country
INESC TEC	Edward Knightly	Rice University	USA
INESC TEC	Elsa Angelini	Telecom Paris	France
INESC TEC	John J. Leonard	MIT, Department of Mechanical Engineering	USA
INESC TEC	Maria Grazia Speranza	Università degli Studi di Brescia	Italy
INESC TEC	Mario Paolone	EPFL - L'Ecole Polytechnique Fédérale de Lausanne	Switzerland
INESC TEC	Masaru Kitsuregawa	Institute of Industrial Science, The University of Tokyo	Japan
INESC TEC	Robert Lieberman	SPIE – The International Society for Optics and Photonics; Lumoptix LLC	USA
INESC TEC	Tomás Gómez San Román	Universidad Pontificia Comillas	Spain
INESC TEC	Volker Stich	Aachen University of Technology	Germany
INESC TEC	Virginia Dignum	Umeå University	Sweden

ANNEX I – RESEARCHERS FROM EACH RESEARCH GROUP – (RELATED TO PHASE 2 – TEAM REGISTRATION)

The wording of the listed names corresponds to the one recorded on the platform by the researchers themselves.

12.2 AI - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal investigator: Alípio Mário Guedes Jorge

1. Abílio Carlos Pereira Pacheco
2. Alberto Adrego Pinto
3. Álvaro Pedro de Barros Borges Reis Figueira
4. ana filipa pinheiro sequeira
5. Ana Maria Rodrigues de Sousa Faria de Mendonça
6. Ana Rita Dias Nogueira
7. André Borges Guimarães Serra e Santos
8. Andry Maykol Pinto
9. Aníbal Castilho Coimbra de Matos
10. António Sousa
11. Armando Jorge Miranda de Sousa
12. Arsénio Monteiro dos Reis
13. Bruno Miguel Paz Mendes de Oliveira
14. Bruno Veloso
15. Carla Gonçalves
16. Carlos Manuel Abreu Gomes Ferreira
17. Davide Rua Carneiro
18. Eduardo José Solteiro Pires
19. ELSA FERREIRA GOMES
20. Fernando Manuel Augusto da Silva
21. Filipe Baptista Neves dos Santos
22. Francesco Renna
23. GERMANO MANUEL CORREIA DOS SANTOS VEIGA
24. Gilberto Bernardes de Almeida
25. Gonçalo Figueira
26. HÉLDER FERNANDO CERQUEIRA ALVES
27. Hélder Filipe Pinto de Oliveira
28. Helder Martins Fontes
29. Hugo Miguel Gomes da Silva
30. Hugo Miguel Mendes Ferreira
31. Ivo André Soares Pereira
32. Jaime Santos Cardoso
33. João Fernandes
34. Joao Gama
35. João Paulo Cunha
36. João Pedro Carvalho Leal Mendes Moreira

37. João Pedrosa
38. Joaquim João Moreira de Sousa
39. Jorge Manuel Correia Pereira
40. Jorge Miguel Silva Valente
41. José Luís Cabral de Moura Borges
42. José Maria Gouveia Martins
43. JOSÉ NUNO MOURA MARQUES FIDALGO
44. José Paulo Barroso de Moura Oliveira
45. José Pedro Fernandes da Silva Coelho
46. Luís André Freitas da Rocha
47. Luis António Pereira de Meneses Corte Real
48. Luís Carlos Feliz dos Santos
49. Luís Filipe Pinto de Almeida Teixeira
50. Luis Lopes
51. Mafalda Teles Roxo
52. Maria Adelaide da Cruz Cerveira
53. Maria Benedita Campos Neves Malheiro
54. Maria da Conceição de Oliveira Nunes Rocha
55. Maria de Fátima Coutinho Rodrigues
56. Maria Eduarda da Rocha Pinto Augusto da Silva
57. MARIA PAULA DE PINHO DE BRITO DUARTE SILVA
58. maria teresa magalhães da silva pinto de andrade
59. Matias Molina
60. Miguel Coimbra
61. Miguel Fernando Paiva Velhote Correia
62. Nuno Alexandre Magalhaes Pereira
63. Nuno Azevedo Silva
64. Nuno Miguel Neves de Abreu
65. Nuno Ricardo Pinheiro da Silva Guimarães
66. Nuno Silva
67. Paula Maria Marques de Moura Gomes Viana
68. Paulo Jorge de Sousa Azevedo
69. Paulo Martins
70. Pedro Campos
71. Pedro Gabriel Dias Ferreira
72. Pedro Manuel Pinto Ribeiro
73. Pedro Miguel Machado Soares Carvalho
74. Quelhas Brito Pedro
75. Rafael Arrais
76. Renato Borges de Araújo de Moura Soeiro
77. Ricardo Campos
78. Ricardo Jorge Gomes de Sousa Bento Bessa
79. Ricardo Jorge Teixeira de Sousa
80. Ricardo Pereira de Magalhães Cruz
81. Rita Paula Almeida Ribeiro
82. RUI CARLOS CAMACHO DE SOUSA FERREIRA DA SILVA
83. Sara Costa Freitas

84. Sérgio Nunes
85. Shazia Tabassum
86. Sónia Manuela Mendes Dias
87. Susana Alexandra Barbosa
88. Tânia Daniela Lopes da Rocha Fontes
89. Tania Pereira Lopes
90. Tiago Pinto
91. Vanessa Alexandra Freitas da Silva
92. VERA LÚCIA MIGUEIS OLIVEIRA E SILVA
93. Vítor Jorge Ramos Rocio
94. Vítor Manuel de Morais Santos Costa

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Afonso Castanheira de Abreu Nabais Baldo
2. Alexandre Henrique da Costa Neto
3. André Levi Ribeiro Tse
4. António Manuel Pinto Correia Alves
5. Artur Rocha
6. AURÉLIO JOAQUIM DE CASTRO CAMPILHO
7. Bruno Alves Pereira
8. Carolina Mendes Catarino Cerveira Albuquerque
9. Celestino Gabriel Portela da Silva
10. Celso Pereira
11. Christina Maria Mastralexi
12. Daniel Filipe Silva Pereira
13. Daniel José Barros Silva
14. Daniela Passos
15. Daniele da Mota Caldana
16. Diogo Marcelo Esterlita Nogueira
17. Eduardo de Matos Rodrigues
18. Filipe Emanuel dos Santos Marinho da Rocha
19. Filipe Vamonde de Oliveira
20. Francisco Manuel Barbosa Ribeiro
21. Gonçalo Duarte Nunes
22. Haline Maia
23. Hugo Miguel Oliveira de Sosua
24. Inês Alves Barbosa
25. Inês de Sousa Cardoso
26. Joana Costa
27. João Miguel Pinto Pereira da Silva
28. João Paulo Rocha Viana
29. Jose Diogo Pereira Tender Dias
30. José Pedro Pinto
31. Luís Filipe Pires Henriques
32. Mafalda Rodrigues Castro
33. Mansur Mustafin

34. Manuel José Pereira Curral
35. Márcio Cláudio Silva Duarte
36. Maria Eduarda Loureiro Caldeira
37. Maria Francisca de Sousa Almeida
38. Maria Inês Paiva Costa Amaro
39. Maria Rita Nogueira Lopes
40. Mariana Rodrigues Almeida
41. Matias Lessa Vaz
42. MIGUEL ÂNGELO MACHADO GUIMARÃES
43. Miguel Jorge Raposo Nunes de Andrade
44. MIGUEL SOUSA
45. Nuno Filipe de Almeida Valente
46. Nuno Moura da Costa
47. Pavel Brazdil
48. RAFAEL DE CARVALHO MAIA PARENTE MAMEDE
49. Rui Jorge Eduardo Ramos
50. Rui Manuel Azevedo dos Santos
51. Sónia Andreia Pires Ferreira
52. Tânia Maria Carvalho Leite Mendes
53. Tony Williams Alves Ferreira
54. Valentino Carneiro Gonçalves
55. Vítor Emanuel Moreira Ventuzelos
56. Zijjing Cao

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. Ahmed Adel Fares Gadelrab Mohamed
2. Ana Cláudia Carvalhais Teixeira
3. Ana Filipa Rodrigues Nogueira
4. Ana Margarida Mendes Antunes Martins Victoriano
5. Ana Sofia Cabral Cardoso
6. Artur Cordeiro
7. Bernardo Teixeira
8. Bruno Fonseca Oliveira Coelho
9. CATARINA FREITAS DE SOUSA SANTOS
10. Cristiano Pires Patrício
11. Daniel Queirós da Silva
12. Eduardo Nuno Almeida
13. Ehsan Aminian
14. Felipe Tetsuo Yamada
15. Francisco Alexandre Lourenço Maia
16. Francisco Silva
17. Francisco Soares Pinto da Silva Neves
18. Francisco Sousa Lobo
19. GABRIEL ANTONIO PEREIRA DOS SANTOS CARNEIRO
20. Germano Moreira

21. Gil Sampaio
22. Gonçalo da Mota Laranjeira Torres Leão
23. Inês Filipa Fernandes Videira Lopes
24. Isabel Alexandra Fernandes Vaz Pinheiro
25. Isabel Cristina Rio-Torto de Oliveira
26. Joana Vale Amaro de Sousa
27. JOAO AFONSO BRAUN NETO
28. João Diogo Fernandes Freitas Nunes
29. João Manuel Maia Dionísio
30. Jorge Rodríguez
31. LEANDRO DE ALMEIDA RODRIGUES
32. Lourenço Sousa de Pinho
33. Luís Fernandes
34. Luís Filipe Costa Cunha
35. LUÍS MIGUEL SALGADO NUNES VILAÇA
36. Margarida Antunes da Costa
37. Margarida Gonçalves Gouveia
38. Maria Alexandra Ramalho de Oliveira
39. Maria Helena Sampaio de Mendonça Montenegro e Almeida
40. Maria Inês Pinto Bastos Martins
41. Maria Inês Rodrigues Pereira
42. Maria José Gomes Pedoto
43. MARIANA FERREIRA DIAS
44. Marta Carolina Cabral Moreno
45. Md Tahsir Ahmed Munna
46. Mohammad Hossein Zolfagharnasab
47. Nádia Carvalho
48. Nelson Bilber Rodrigues
49. Nuno André Azevedo Marques
50. Nuno Pinheiro da Silva Mota Freitas
51. Paula Raissa Costa e Silva
52. Paulo Jorge Silva Ferreira
53. Pedro David Carneiro Neto
54. PEDRO DIAS REIS
55. Pedro Emanuel de Alves Guedes
56. Pedro Nuno Barbosa Leite
57. Rafael Marques Claro
58. Rogério Eduardo Ramos Ribeiro
59. Rui Pedro Castro Nascimento
60. Samuel Pereira
61. SANDRO AUGUSTO COSTA MAGALHÃES
62. Serkan Sülün
63. Solander Patricio Lopes Agostinho
64. Sónia Alexandra Carvalho Teixeira
65. SUSANA VITÓRIA SÁ SILVA MARQUES
66. Tamás Karácsony
67. Tânia Filipa Fernandes de Melo

68. Thiago Andrade
69. Tiago André Miranda dos Santos
70. Tiago André Queiroz Soares da Costa
71. Tiago António Dias Costa Carvalho Mendes
72. Tiago Filipe Sousa Gonçalves
73. Tiago Mendes Neves
74. Tomé Mendes Albuquerque
75. Yago Melo Rodrigues da Silva
76. Yassine Baghoussi
77. Yohannes Ejigu

12.2 BIO - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal Investigator: João Paulo Cunha

1. ana filipa pinheiro sequeira
2. Ana Maria Rodrigues de Sousa Faria de Mendonça
3. Ana Paula Magalhães Lima
4. Ana Rita Rego Lopes
5. Carla Susana Santana Carmelo Rosa
6. Daniel Fernando Marques de Vasconcelos
7. Eduardo José Solteiro Pires
8. ELSA FERREIRA GOMES
9. Francesco Renna
10. Gilberto Bernardes de Almeida
11. Hélder Filipe Pinto de Oliveira
12. Jaime Santos Cardoso
13. João Pedrosa
14. José Alberto Peixoto Machado da Silva
15. José Francisco Creissac Freitas de Campos
16. José Manuel Marques Martins de Almeida
17. Luis Carlos Costa Coelho
18. Luis Filipe Coelho
19. LUÍS MANUEL COUTO DE OLIVEIRA
20. Manuel Fernando Santos Silva
21. Mário Manuel de Miranda Furtado Campos Cunha
22. MARTA MACEDO VRANAS
23. Miguel Coimbra
24. Miguel Fernando Paiva Velhote Correia
25. Nuno Miguel Feixa Rodrigues
26. Pedro Gabriel Dias Ferreira
27. Pedro Henrique Henriques Guedes de Oliveira
28. Rui Miguel da Costa Martins
29. Sónia Manuela Mendes Dias

30. Susana Cristina Ribeiro Novais
31. Susana Rodrigues
32. Tania Pereira Lopes

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Adriana Arrais
2. Adriana João Falcão Neves
3. Ana Marta de Oliveira Dias
4. Artur Rocha
5. AURÉLIO JOAQUIM DE CASTRO CAMPILHO
6. Bruna Manuela Teixeira Alves
7. DALILA ISABEL SOUSA BARBOSA
8. Daniel David Proaño Guevara
9. Daniel José Barros Silva
10. DIOGO DE ALMEIDA CAMPAS
11. Duarte Dias
12. Francisca da Cruz Patrão
13. Francisco Samuel Neves Fidalgo
14. Hugo Oliveira
15. Inês Castro Teiga
16. Ireneu Manuel Silva Dias
17. João Afonso Martins Domingues Andrade
18. João Matos
19. JOÃO PEDRO MARTINS MONTREZOL CAMILO ANTUNES
20. Luis Eduardo Ruano Argueta
21. Marco Aurélio Amaro Oliveira
22. Maria Eduarda Loureiro Caldeira
23. Maria Inês Paiva Costa Amaro
24. Martim José De Pinho Gutierrez Silva
25. Miguel Filipe Fernandes Fontes
26. Miguel Rocha
27. Pedro Santos Pereira
28. Pedro Sousa
29. Raul Viana
30. Ricardo Miguel Silva Ferreira
31. Rita Duarte Pinho Vieira
32. Rodrigo de Carvalho Vagarinho Raimundo Fernandes
33. Rui Manuel Azevedo dos Santos
34. Tiago Filipe Oliveira da Silva

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. Aline dos Santos Silva
2. Beatriz Pedrosa Cepa
3. Bruno Fonseca Oliveira Coelho

4. Carlos Alexandre Nunes Ferreira
5. Cláudia Daniela Costa Rocha
6. Elodie Múrias Lopes
7. Francisco Vieira
8. Gonçalo Gonçalves
9. Inês Filipa Fernandes Videira Lopes
10. Joana Maria Neves da Rocha
11. Joana Vale Amaro de Sousa
12. João Diogo Fernandes Freitas Nunes
13. Liliana Patrícia Santos Soares
14. Mafalda Alexandra Reis Pereira
15. Margarida Gonçalves Gouveia
16. Maria do Rosário Santos Pinheiro
17. Miguel Lopes Martins
18. Pedro Gil Lima Freitas
19. Renan Tosin
20. Sofia Alexandra Gonçalves Ferraz
21. Sofia Perestrelo de Vasconcelos Cardoso Pereira
22. Tamás Karácsony
23. Tânia Filipa Fernandes de Melo
24. Vitor Daniel Veigas Minhoto

12.2 COM - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal Investigator: Manuel Ricardo

1. André Coelho
2. Aníbal João Sousa Ferreira
3. António Alberto Santos Pinto
4. António Luís Gomes Valente
5. Artur Manuel Oliveira Andrade Moura
6. Helder Martins Fontes
7. HENRIQUE MANUEL DE CASTRO FARIA SALGADO
8. Joana dos Santos Tavares
9. João Marco Cardoso da Silva
10. João Vilela
11. José Alberto Peixoto Machado da Silva
12. Luis Armando de Aguiar Oliveira Gomes
13. Luis Miguel Moreira Lino Ferreira
14. Luís Pessoa
15. Manuel Joaquim Bastos Marques
16. Marcos Martins
17. Maria Sousa
18. maria teresa magalhães da silva pinto de andrade

19. Mário João Gonçalves Antunes
20. Nuno Alexandre Magalhaes Pereira
21. Nuno Miguel Cardanha Paulino
22. Nuno Teixeira de Almeida
23. Orlando José Reis Frazão
24. Paula Maria Marques de Moura Gomes Viana
25. Pedro Miguel Machado Soares Carvalho
26. Quelhas Brito Pedro
27. Rolando Silva Martins
28. Rui Campos
29. Tiago Hipkin Meireles

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Andre Costa
2. ANDRÉ NUNO DE PINHO TAVARES GURGO E CIRNE
3. Filipe Ribeiro
4. Francisco Manuel Barbosa Ribeiro
5. Guilherme Moreira
6. Haline Maia
7. Henrique José Silva Bastos Sul da Rocha
8. Leonardo Gomes Capozzi
9. Mariana Silva Fonseca de Barros Oliveira
10. Miguel Augusto Marombal Araújo
11. Nuno André Pinto de Sousa
12. Paulo Fidalgo
13. Paulo João Lima Vanzeler Monteiro
14. Pedro Lopes
15. Rafael Amaral Pina Aguiar
16. Sérgio Miguel Marques Ribeiro da Silva
17. Tiago da Silva Ribeiro
18. Valentino Carneiro Gonçalves
19. Wagner Daniel Teixeira Pedrosa
20. Wánderston Cássio Oliveira Araújo

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. CARLOS ANTÓNIO DE SOUSA COSTA NOVO
2. Eduardo Nuno Almeida
3. Fábio Martinho Cardoso
4. Filipe Borges Teixeira
5. Gabriella Fernandes Pantaleão
6. Gonçalo Moura Tomé Fraguito Queirós
7. João Henrique Melro Araújo
8. João Pedro Teixeira Loureiro
9. José Pedro Afonso Gomes Luís

10. Juliana Carvalho Cortes Silva
11. Julio Gabriel Chilela
12. kamran Shafafi
13. Mayara Emilia Barbosa Souza
14. Mohamed Elsaid Abdelaal Mohamed Ghatas
15. PEDRO MIGUEL MONTEIRO RIBEIRO
16. Ricardo Jorge Espírito Santo Trancoso
17. Rúben Miguel Rei Queirós
18. Sanaâ FINICH
19. Sofia Isabel Silva Inácio
20. Tiago André Queiroz Soares da Costa

12.2 CSE - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal Investigator: José Orlando Roque Nascimento Pereira

1. Adelaide Maria Sousa Figueiredo
2. Ademar Aguiar
3. Alexandra Sofia Ferreira Mendes
4. Alexandre Valle de Carvalho
5. Álvaro Pedro de Barros Borges Reis Figueira
6. Ana Cristina Ramada Paiva
7. ANA LUÍSA PARREIRA NUNES ALONSO
8. André Martins Pereira
9. Angelo Manuel Rego Silva Martins
10. António Alberto Santos Pinto
11. ANTÓNIO AUGUSTO DE SOUSA
12. António Fernando Coelho
13. António José Duarte Araújo
14. António Luís Pinto Ferreira de Sousa
15. António Manuel de Sousa Barros
16. António Manuel Nestor Ribeiro
17. António Sousa
18. Arsénio Monteiro dos Reis
19. Bernardo Luís Fernandes Portela
20. Carla Alexandra Teixeira Lopes
21. Carlos Miguel Ferraz Baquero Moreno
22. Daniel Filipe Martins Tavares Mendes
23. Diana Carvalho
24. Eduardo Resende Brandão Marques
25. Eva Ferreira de Oliveira
26. Evelin Freire de Amorim
27. Fábio André Castanheira Luis Coelho
28. Fernando Cassola

29. Fernando Manuel Augusto da Silva
30. Filipe Alexandre Pais de Figueiredo Correia
31. FRANCISCO COELHO SOARES DE MOURA
32. Frederico Augusto dos Santos Branco
33. Gabriel David
34. Hélio Mendes de Sousa Mendonça
35. HUGO ALEXANDRE PAREDES GUEDES DA SILVA
36. Hugo José Pereira Pacheco
37. Hugo Sereno Ferreira
38. Ivo André Soares Pereira
39. Jácome Cunha
40. João Aguiar de Castro
41. João Alexandre Baptista Vieira Saraiva
42. JOÃO ANTÓNIO CORREIA LOPES
43. João Cardoso
44. João Carlos Pascoal Faria
45. João Carlos Viegas Martins Bispo
46. João Manuel Pereira Barroso
47. João Marco Cardoso da Silva
48. João Miguel Maia Soares de Resende
49. João Paulo de Castro Canas Ferreira
50. João Tiago de Medeiros Paulo
51. João Vilela
52. JORGE MIGUEL DE MATOS SOUSA PINTO
53. Jorge Miguel Silva Valente
54. José Alfredo Ribeiro da Silva Matos
55. José Benjamim Ribeiro da Fonseca
56. JOSÉ BERNARDO DOS SANTOS MONTEIRO VIEIRA DE BARROS
57. José Carlos Bacelar Almeida
58. José Carlos dos Santos Alves
59. José Francisco Creissac Freitas de Campos
60. José Henrique Pereira São Mamede
61. José Nuno Oliveira
62. José Paulo de Vilhena Geraldés Leal
63. José Vasconcelos Raposo
64. LEONEL CASEIRO MORGADO
65. LEONEL DOMINGOS TELO NÓBREGA
66. LUÍS FILIPE LEITE BARBOSA
67. Luis Lopes
68. Luis Miguel Moreira Lino Ferreira
69. Luís Miguel Rosário da Silva Pinho
70. Luis Paulo Peixoto dos Santos
71. Luís Soares Barbosa
72. MALAK MASNAD IRSHED AL-QBILAT AL-QBILAT
73. Manuel Alcino Pereira da Cunha
74. Manuel Barbosa
75. Manuel Cândido Duarte dos Santos

76. Manuel Eduardo Carvalho Duarte Correia
77. Manuel Firmino da Silva Torres
78. Marcelo Petry
79. Maria Cristina de Carvalho Alves Ribeiro
80. Maria de Fátima Coutinho Rodrigues
81. MARIA JOÃO GOMES FRADE
82. Maria Teresa Galvão Dias
83. Mariana Curado Malta
84. Mário João Gonçalves Antunes
85. Maximino Esteves Correia Bessa
86. Miguel Ângelo Correia de Melo
87. Miguel João Gonçalves Areias
88. Miguel Leitão
89. Narjes Davari
90. Norihiro Yamada
91. Nuno Bettencourt
92. Nuno Honório Rodrigues Flores
93. Nuno Macedo
94. Nuno Miguel Cardanha Paulino
95. Nuno Miguel Feixa Rodrigues
96. Olga Maria Gomes Martins Pacheco
97. Paulo Gabriel Gadelha Queiroz
98. Paulo João Figueiredo Cabral Teles
99. Paulo Jorge de Sousa Azevedo
100. PAULO MANUEL BALTAREJO DE SOUSA
101. Paulo Martins
102. Paulo Sérgio Soares de Almeida
103. Pedro Manuel Pinto Ribeiro
104. Rafael Arrais
105. Ramiro Manuel Ramos Moreira Gonçalves
106. Renato Borges de Araújo de Moura Soeiro
107. RENATO JORGE ARAÚJO NEVES
108. Ricardo Alexandre Peixoto de Queirós
109. RICARDO AUGUSTO RODRIGUES DA SILVA SEVERINO
110. Ricardo Gonçalves Macedo
111. Ricardo Jorge Gomes Lopes da Rocha
112. RICARDO MANUEL PEREIRA VILAÇA
113. Rolando Silva Martins
114. Rui Oliveira
115. Rui Rodrigues
116. Sandra Maria Mendes Alves
117. Sérgio Nunes
118. Susana Alexandra Barbosa
119. Susana Nicola
120. Tânia de Jesus Vilela da Rocha
121. Vítor Francisco Mendes de Freitas Gomes da Fonte
122. Vítor Manuel de Morais Santos Costa

123. Vitor Manuel Grade Tavares

124. Vitor Manuel Jesus Filipe

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Adriano Novo Soto Maior
2. Afonso Castanheira de Abreu Nabais Baldo
3. Alberto Barbosa
4. Alexandre Costa
5. Ana Carolina Marques Chaves
6. Ana Marta de Oliveira Dias
7. Andre Costa
8. André da Silva Gonçalves
9. ANDRÉ NUNO DE PINHO TAVARES GURGO E CIRNE
10. ANTÓNIO MIGUEL PONTES PIMENTA MONTEIRO
11. Bianca Barbuto Lima
12. BRUNO FILIPE MIRANDA PEREIRA
13. CARLOS JOSÉ RIBEIRO CAMPOS
14. CAROLINA MARTINS CATORZE
15. DANIEL BARBOSA MIRANDA
16. David Andrade Rainho
17. Denys Sytnyk
18. Diana Abreu Machado Azevedo Rodrigues
19. Diogo Alexandre Ribeiro da Costa
20. Eduardo de Matos Rodrigues
21. Filipe Vamonde de Oliveira
22. Francisco Vilarinho
23. Guilherme Artur Conceição Capela
24. Guilherme Lima Barros Gomes Fernandes
25. HUGO MANUEL SANTOS MOÇO
26. Hugo Silva
27. Inês Alves Barbosa
28. Inês de Sousa Cardoso
29. Joana Maia Alves
30. Joana Patrícia Sousa Rodrigues
31. João Agostinho Batista de Lacerda Pavão
32. João António Gamboa Correia
33. JOÃO CARLOS GARCIA DA CUNHA BARBOSA
34. JOÃO CARLOS TOMÉ DIAS
35. João Francisco Ferreira Martins Pereira
36. João Imperadeiro
37. Jony Ricardo Mesquita Xavier Costa
38. Jorge Esparteiro Garcia
39. José Correia
40. Jose Diogo Pereira Tender Dias
41. José Lino Marques de Oliveira
42. José Luís Cunha Rodrigues

43. José Pedro Dias Nascimento Fernandes
44. José Pedro Ribeiro Peixoto
45. Juliana Vieira Valentim
46. Luís Diogo de Almeida Outeiro
47. Luís Manuel Fernandes Pereira
48. Mafalda Barros de Sousa
49. Mafalda Rodrigues Castro
50. MANUEL BENTO BARBOSA DO COUTO
51. Manuel Cerqueira da Silva
52. Manuel Quintas Monteiro de Barros
53. Marco Aurélio Amaro Oliveira
54. Maria da Conceição Pereira Tavares
55. Maria Francisca de Sousa Almeida
56. Maria José Costa Ramos
57. Mariana do Carmo Araújo Amorim
58. Mariana Mirra Monteiro
59. Mariana Silva Fonseca de Barros Oliveira
60. Mário Ricardo de Novais Henriques
61. Miguel Correia
62. Miguel de Albuquerque Araujo
63. Miguel Jorge Raposo Nunes de Andrade
64. Miguel Maio Romariz
65. MIGUEL SOUSA
66. Nelson José De Oliveira Neto
67. Nuno André Pinto de Sousa
68. Nuno Filipe Pinto Faria
69. Pedro Guilherme Alves Sousa
70. Pedro Miguel Braga Moreira
71. Pedro Miguel de Leal Meireles Pereira
72. Pedro Miguel Marques Ferreira
73. Pedro Miguel Moreira Ramalho
74. Pedro Miguel Pereira de Melo
75. Rafael Braga Gomes da Costa
76. Raul Viana
77. Ricardo Filipe da Costa Alexandre Conceição Silva
78. RICARDO JOSÉ BORGES RODRIGUES
79. RICARDO JOSÉ VIEIRA BAPTISTA
80. RÚBEN DANIEL ALMEIDA ADÃO
81. Rui Jorge Eduardo Ramos
82. RUI PEDRO CARVALHO MACHADO
83. Rui Pedro Ferreira Mendonça
84. Sara Lima Pereira
85. Sergio dos Reis Marques Madeira
86. Sónia Andreia Pires Ferreira
87. Sylwia Bugla
88. TADEU AUGUSTO LEITE FREITAS
- 89. Tiago Diogo Ribeiro de Carvalho**

90. Tiago José Sousa Oliveira
91. Tiago Pereira
92. Vinícius Batista Ferreira dos Reis
93. Zijing Cao

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. Ahmed Adel Fares Gadelrab Mohamed
2. Alexandra Francisco Ramôa da Costa Alves
3. Alexandre Almeida de Abreu Filho
4. Américo José Rodrigues Pereira
5. Ana Isabel Carvalho Neri
6. Ana Margarida Mendes Antunes Martins Victoriano
7. André Fernandes dos Santos
8. André Meira
9. André Sequeira
10. André Thiago Corrêa Netto
11. Beatriz Pedrosa Cepa
12. Bruno Lopes Matias
13. BRUNO MIGUEL GONÇALVES SARAIVA
14. Bruno Peixoto
15. CARLOS ANTÓNIO DE SOUSA COSTA NOVO
16. Carlos Eduardo da Nova Duarte
17. CATARINA FREITAS DE SOUSA SANTOS
18. Cláudia Vanessa Martins de Brito
19. Cristiane Jorge de Lima Bonfim Crisjorge
20. Daniel Ribeiro de Pinho
21. demetrius lacet
22. Dennis Lourenço Paulino
23. Diana Quitéria Teixeira de Sousa
24. Dinis Filipe da Silva Trigo
25. Diogo Guimarães
26. Diogo Pinto Ribeiro
27. Ema Carolina Barbosa da Assunção Pereira
28. Ezequiel José Veloso Ferreira Moreira
29. Francisco Alexandre Lourenço Maia
30. Francisco Ribeiro
31. Gabriel de Jesus
32. Guilherme Luís Leitão Teixeira Guia de Carvalho
33. Guilherme Santos Gonçalves
34. Helder Henrique Avelar
35. HENRIQUE JOSÉ CARVALHO FARIA
36. Hugo Gião
37. Hugo Rafael Mendes Coelho
38. Inês Dias Koch
39. Inês Filipa Nunes Teixeira

40. Jaime Santos
41. João Diogo De Faria Miranda Duarte
42. João Miguel Ramos Chaves Fernandes
43. João Pedro Araújo Parente
44. José Carlos Paiva
45. JOSÉ EMANUEL SILVA RODRIGUES
46. José Nuno Castro de Macedo
47. Juliana Patrício de Souza
48. Lázaro Costa
49. Luciano Polónia Gonçalves Grácio
50. Luís Alberto Oliveira Rocha Esquível Costa
51. Luís Manuel Meruje Ferreira
52. Luís Miguel Mendes Pimentel Alves de Sousa
53. LUÍS MIGUEL SALGADO NUNES VILAÇA
54. Mafalda Francisco Ramôa da Costa Alves
55. Maria Inês Pinto Bastos Martins
56. Mariana da Cruz Cunha
57. Mariana Magalhães
58. Mariana Martins de Sá Miranda
59. Marisa Pinheiro
60. Masoud Golalikhani
61. Mohammad Gulam Lorgat
62. Nelson Bilber Rodrigues
63. Nico Maximilian Wittrock
64. Núbio Vidal de Negreiros Gomes Filho
65. Óscar Martins
66. Pedro Carvalho Moreno
67. Pedro Faria Durães da Silva
68. Pedro Miguel Ermida Monteiro
69. Ricardo Jorge Moreira da Silva Neves
70. Rui António Ramada Rua
71. Rui Pedro da Cunha Monteiro
72. Sara Ali
73. Sara Filipa Couto Fernandes
74. SOFIA GUILHERME RODRIGUES DOS SANTOS
75. SUSANA VITÓRIA SÁ SILVA MARQUES
76. Tânia da Conceição Araújo Esteves
77. Tiago Carlos Caló Fonseca
78. Tiago Nuno Mesquita Folgado Leitão Devezas
79. Tiago Santos
80. Vasco Miguel Gonçalves Correia
81. Vicente Vieira Rocha
82. Vítor Emanuel Gonçalves Fernandes
83. Yassine Baghoussi
84. Yohannes Ejigu

12.2 PHT - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal Investigator: Paulo Vicente Silva Marques

1. Ariel Ricardo Negro da Silva Guerreiro
2. Carla Susana Santana Carmelo Rosa
3. Catarina da Silva Monteiro
4. Claudio Floridia
5. Daniel Moreira Lopes Alexandre
6. Diana Catarino das Neves Viegas
7. Diana Filipa Carmo Guimarães Dias Guedes
8. João Miguel Mendes da Silva Maia
9. João Pedro Sampaio Mendes
10. José Luís Santos
11. José Manuel Marques Martins de Almeida
12. Luis Armando de Aguiar Oliveira Gomes
13. Luis Carlos Costa Coelho
14. LUÍS MANUEL COUTO DE OLIVEIRA
15. Manuel Joaquim Bastos Marques
16. Maria Inês Barbosa de Carvalho
17. Nuno Azevedo Silva
18. Orlando José Reis Frazão
19. Paulo Caldas
20. Pedro Alberto da Silva Jorge
21. Susana Cristina Ribeiro Novais
22. Susana Ferreira de Oliveira Silva

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Bernardo de Meireles Carneiro
2. Cristina Cunha
3. Francisco Alberto da Silva Rocha
4. Ireneu Manuel Silva Dias
5. Pedro Henrique Fernandes Moura
6. Rita Pereira de Faria

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. Aníbal Filipe Marques Monteiro da Silva
2. ANTÓNIO VAZ RODRIGUES
3. Beatriz Gomes Soares
4. Carlos Duarte Rodrigues Viveiros
5. Diana Faria Capela
6. Joana Magalhães Baptista Teixeira

7. João Paulo Carmo Silva
8. Liliana Patrícia Santos Soares
9. Mafalda Alexandra Reis Pereira
10. MIGUEL ÂNGELO SILVA ALMEIDA
11. Miguel Fernandes Soares Ferreira
12. Paulo Manuel Ribeiro Robalinho
13. PAULO SÉRGIO SOARES DOS SANTOS
14. PEDRO MIGUEL MADEIRA DA SILVA
15. Renan Tosin
16. Tiago David Silva Ferreira
17. Tomás José Moreira Lopes
18. Vicente Vieira Rocha

12.2 PES - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal Investigator: Ricardo Jorge Gomes de Sousa Bento Bessa

1. Adrian Carrillo Galvez
2. Alexandre Miguel Marques Silveira
3. Alexandre Nuno Rocha Pinto Lucas
4. Bernardo Marques Amaral Silva
5. Carla Gonçalves
6. CARLOS COELHO LEAL MONTEIRO MOREIRA
7. Carlos Henrique Tarjano Santos
8. Christian Cooke
9. Clara Sofia Teixeira Gouveia Moura
10. Cleberton Reiz
11. David Emanuel da Silva Rua
12. Ehsan Kazemi-Robati
13. Filipe Azevedo
14. FILIPE JOEL NUNES SOARES
15. giovanni buroni
16. Hermano Joaquim dos Santos Bernardo
17. Ignacio Hernando-Gil
18. ISAÍAS DA LUZ RAMOS GOMES
19. Joao Paulo Tome Saraiva
20. João Peças Lopes
21. Jorge Manuel Correia Pereira
22. José Manuel Ribeiro Baptista
23. JOSÉ NUNO MOURA MARQUES FIDALGO
24. José Rui da Rocha Pinto Ferreira
25. Jose Villar Collado
26. Justino Rodrigues
27. Karol Bot

28. Leonel Carvalho
29. LIA RAQUEL NETO MARTINS DE LIMA PATRÍCIO
30. Luis Guimarães
31. Manuel António Cerqueira da Costa Matos
32. Maria Adelaide da Cruz Cerveira
33. Maria da Conceição de Oliveira Nunes Rocha
34. Maria Helena Osório Pestana de Vasconcelos
35. Mohammad Sadegh Javadi Estahbanati
36. Renan Kovalczuk Portelinha
37. Rui Manuel Esteves Araújo
38. Tiago André Teixeira Soares
39. Vladimiro Henrique Barrosa Pinto de Miranda
40. Zenaida Sobral Mourao

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Allon Soares da Silva
2. Ana Sofia Carvalho da Silva
3. ANDRÉ FILIPE MARQUES CUNHA
4. Andre Garcia
5. André Gustavo Lourenço Melim
6. António Gonçalo Silva Pinto da Cunha
7. António Sérgio Barbosa Faria
8. Armando Moreno
9. Bernardo Miguel Nunes Ribeiro
10. BETINA BAÈRE DE FARIA CAMPOS NEVES
11. Bianca Barbutto Lima
12. Brivaldo batista da silva filho
13. Bruno Lobato Oliveira Palley
14. Carlos Manuel Rodrigues Pereira
15. Celestino Gabriel Portela da Silva
16. Chad Alfie Watson
17. David Capitao Lima
18. Delcio Morais
19. Diogo André Pereira Babo
20. Fabio Cruz
21. Fernando Henrique Maia de Paula
22. Filipe Tadeu Oliveira
23. Flávio de Sousa Pesse
24. Francisco Tavares Ventura Barros Nunes
25. Gonçalo José Pita Macedo
26. Henrique Manuel Rendall Evora
27. Henrique Teixeira
28. Iliia Ponomarev
29. Isabelle Bonioli de Andrade
30. Jacinta Dias Ferreira
31. João Carlos Agrela Freitas

32. João Francisco Ferreira da Rocha Silva
33. João Paulo de Brito Pacheco
34. João Paulo Rocha Viana
35. João Pedro Azeredo Aguiar
36. João Pedro da Costa Sousa
37. José Brito
38. José Luís Cunha Rodrigues
39. José Pedro Ferreira Pelicano Paulos
40. José Pedro Ribeiro de Sousa
41. José Ricardo Santos Andrade
42. Lourenço Miguel Ferreira Espírito Santo
43. Luís Manuel Dias Rodrigues
44. Luis Miguel Lopo dos Santos Seca
45. MANUEL VAZ DE ALMEIDA DA SILVA CASTRO
46. MD WAKIL AHMAD
47. Micael Simões
48. Miguel Preto
49. Morteza Vahid Ghavidel
50. Olga Klyagina
51. Paulo João Lima Vanzeler Monteiro
52. Pedro Benedicto Martínez
53. Pedro Bernardo Pereira Santos
54. Pedro Gelati Pascoal
55. Pedro Miguel Ferreira Macedo
56. Pedro Nuno Pereira Barbeiro
57. Ricardo Emanuel Gomes Fernandes da Silva
58. Rodrigo Nascimento Pereira Martins
59. Rui Miguel Mendes Brito
60. Rui Pinto de Sousa
61. Salvador Doménech Martínez
62. Sara Sadat Golmaryami
63. Sofia Varotto
64. Susana Bayo Besteiro
65. Tatiana Pontual Guedes
66. Tiago Ferreira de Castro te Lintel Hekkert
67. Tiago Filipe da Costa Bessa
68. Tiago Oliveira Teixeira
69. Tomás Miguel Barosa dos Santos
70. Túlio Soares
71. Vasco Campos
72. Vasco Rafael Maia Ribeiro Guedes
73. Wellington Winícius Ferreira Fonseca

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. Abdelrahman Muneer Elhawash

2. André Rodrigues de Oliveira
3. Bruna Daniela Costa Tavares
4. Carlos Alberto Madureira da Silva
5. Carlos José Seabra da Costa Oliveira
6. Everton Leandro Alves
7. FÁBIO SESTER RETORTA RETORTA
8. Felipe Dantas do Carmo
9. Ferinar Moaidi
10. Fernando José Moutinho Ribeiro
11. Francisco de Sousa Fernandes
12. Francisco Sousa Lobo
13. Gil Sampaio
14. Igor Roberto Rezende e Castro de Abreu
15. Inês Maria Afonso Trigo de Freitas Alves
16. João Moreira Schneider de Mello
17. João Paulo Fontoura de Oliveira
18. Luciana Narumi Oshiro Yamada
19. Manuel Pinto Neves Aires de Matos
20. Margarida Antunes da Costa
21. Mariana de Souza
22. Nuno Fonseca
23. Pedro Miguel Cardoso Félix
24. Renato da Silva Fernandes
25. Ricardo Jorge Duque Fernandes da Costa Ferreira
26. Rodrigo Miguel Castro Lopes Melo Vieira
27. Salvador Moreira Paes Carvalhosa
28. Tiago João Amorim Abreu
29. Tomás Pinto de Freitas Teixeira da Rocha

12.2 ROB - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal Investigator: ANTÓNIO PAULO GOMES MENDES MOREIRA

1. Ana Cristina Pires de Oliveira
2. André Miguel Pinheiro Dias
3. André Silva Pinto de Aguiar
4. Andry Maykol Pinto
5. Aníbal Castilho Coimbra de Matos
6. António Luís Gomes Valente
7. Armando Jorge Miranda de Sousa
8. Bruno Miguel Mateus Ferreira
9. Diana Catarino das Neves Viegas
10. Eduardo Alexandre Pereira da Silva
11. Filipe Baptista Neves dos Santos

12. GERMANO MANUEL CORREIA DOS SANTOS VEIGA
13. Héber Miguel Plácido Sobreira
14. Hugo Miguel Gomes da Silva
15. João Pedro Carvalho de Souza
16. Jose Boaventura Ribeiro da Cunha
17. José Paulo Barroso de Moura Oliveira
18. Luís André Freitas da Rocha
19. Luís Carlos Feliz dos Santos
20. Manuel Fernando Santos Silva
21. Marcos Martins
22. Maria Benedita Campos Neves Malheiro
23. Mário Manuel de Miranda Furtado Campos Cunha
24. Nuno Alexandre Cruz
25. Nuno Miguel Neves de Abreu
26. Paulo Jorge de Azvedo Lopes dos Santos
27. Paulo José Cerqueira Gomes da Costa
28. Paulo Manuel Dinis Mónica de Oliveira
29. Pedro Luís Cerqueira Gomes da Costa
30. Sara Costa Freitas
31. Tatiana de Fátima Martins Pinho

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Adriana João Falcão Neves
2. Alexandre Carvalho
3. Alfredo Manuel Oliveira Martins
4. Ana Margarida Lago Biltes Vieira Lopes
5. ANA MARIA SILVA MOREIRA DE CARVALHO
6. André Filipe Oliveira Moura
7. André Pinto
8. André Silva Marques
9. António Francisco Rodrigues Carneiro
10. Bárbara Freitas Fernandes
11. BETINA BAÈRE DE FARIA CAMPOS NEVES
12. Bruna Pinheiro
13. Carlos Almeida
14. Celso Pereira
15. Daniele da Mota Caldana
16. Denys Sytnyk
17. Diogo Araújo de Oliveira
18. Diogo Moreira Cabral Machado
19. Diogo Paupério António de Abreu
20. Domingos Bento
21. Eduardo José Pinto Soares
22. Filipe António Rodrigues Cardoso
23. Filipe Reis de Almeida
24. Francisco Miguel Oliveira da Silva Terra

25. Guilherme Marques Amaral Silva
26. Hugo Alexandre Almeida Ferreira
27. HUMBERTO EMANUEL FRANCISCO ROCHA
28. João Ferreira Campanhã
29. João Miguel de Carvalho Oliveira
30. Jorge Diogo Ferreira Ribeiro
31. José Filipe da Silva Oliveira Antunes
32. JOSÉ FRANCISCO MALHEIRO FARIA
33. José Miguel Soares de Almeida
34. José Pedro Mimoso Carvalho
35. Luís Miguel Vieira Lima
36. Maksym Lysak
37. MANUEL BENTO BARBOSA DO COUTO
38. Manuel Pedro dos Santos Reis Pinto da Silva
39. Nuno Dias
40. Paulo Miguel da Cunha Rodrigues
41. Pedro Afonso Da Silva Cardoso Dias
42. Pedro André Peixoto Fonseca de Castro e Silva
43. PEDRO MANUEL BARBOSA GUEDES
44. Pedro Nuno Alexandrino Marques
45. Pedro Pereira
46. Rafael Amaral Pina Aguiar
47. Raquel Carvalho
48. Ricardo André Anes Morais
49. Ricardo Daniel Carneiro Pereira
50. RICARDO OLIVEIRA MOTA
51. Sérgio Daniel Marinho de Lima Teixeira
52. Thiago Baldassarri Levin
53. Tiago Marques Claro
54. Tiago Pereira
55. Vítor Emanuel Moreira Ventuzelos
56. Vítor Tinoco

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. Alexandra Pereira Nunes
2. Alexandre Oliveira
3. ANA CATARINA REMA OLIVEIRA
4. Ana Rita Silva Gaspar
5. André Rodrigues Baltazar
6. António João Almeida Bernardo Ferreira
7. António José Ventura de Oliveira
8. Artur Cordeiro
9. Beril Yalçinkaya
10. Bernardo Teixeira
11. Bruno Lopes Matias

12. Carlos Filipe Silva Gonçalves
13. Carlos Miguel Correia da Costa
14. Cláudia Daniela Costa Rocha
15. Daniel Filipe Barros Campos
16. Daniel Filipe Fernandes Lopes
17. Daniel Queirós da Silva
18. Diogo Miguel Rodrigues Matos
19. Eduardo Almeida d'Azevedo
20. Francisco Adrião Silva Oliveira
21. Francisco Soares Pinto da Silva Neves
22. Gabriel da Silva Martins Loureiro
23. Gabriel de Moura Costa
24. Gonçalo da Mota Laranjeira Torres Leão
25. Igor Godinho Portis
26. Isabel Alexandra Fernandes Vaz Pinheiro
27. João Graça Martins
28. João Manuel Maia Dionísio
29. João Moreira
30. João Pedro Pires Jacob Correia Martins
31. José Eduardo Santos Maravalhas Silva
32. José Maria Queirós Rodrigues Sarmiento
33. Lourenço Sousa de Pinho
34. Maria Inês Rodrigues Pereira
35. Maria Silva Lopes
36. Marina Rodrigues Brilhante
37. Miguel Nakajima Marques
38. Murillo Prestes Villa
39. Paula Alexandra Agra Graça
40. Paulo Miranda Rebelo
41. Pedro Emanuel de Alves Guedes
42. Pedro Miguel Serrão da Veiga Martins
43. Pedro Nuno Barbosa Leite
44. Rafael Marques Claro
45. Renato Jorge Moreira Silva
46. Ricardo Barbosa Sousa
47. Ricardo Jorge Moreira da Silva Neves
48. Rui Manuel Pereira Coutinho
49. SANDRO AUGUSTO COSTA MAGALHÃES
50. Tiago André Miranda dos Santos
51. Yago Melo Rodrigues da Silva

12.2 SEM - Researchers from each Research Group

12.2.1 List of Research Group's Integrated PhD holder Researchers

Select the Leading Researcher and the Integrated PhD holder Researchers that constitute the Research Group from the pre-filled list of Integrated PhD holder Researchers confirmed in the Team Registration menu (with links to the respective CIÊNCIAVITAE and ORCID).

Principal Investigator: LIA RAQUEL NETO MARTINS DE LIMA PATRÍCIO

1. Abílio Carlos Pereira Pacheco
2. Ademar Aguiar
3. Americo Lopes Azevedo
4. Ana Camanho
5. Ana Correia Simões
6. ANA LUÍSA PARREIRA NUNES ALONSO
7. Ana Maria Marques de Moura Gomes Viana
8. Ana Maria Moreira Rodrigues
9. Ana Rita Rego Lopes
10. André Borges Guimarães Serra e Santos
11. António Ernesto Silva Carvalho Brito
12. ANTÓNIO JOSÉ CAETANO BAPTISTA
13. António José Galvão Ramos
14. António Lucas Soares
15. António Manuel Pereira da Silva Amaral
16. António Miguel da Fonseca Fernandes Gomes
17. Armando Luís Ferreira Leitão
18. Bernardo Sobrinho Simões Almada-Lobo
19. Burcu Kubur Özbel
20. Carla Pereira
21. Catarina Marques
22. Cristina Machado Guimarães
23. Cristovão Dinis Polido Sousa
24. Dalila Benedita Machado Martins Fontes
25. Daniel Fernando Marques de Vasconcelos
26. EURICO VASCO FERREIRA AMORIM
27. Fábio Neves-Moreira
28. Farzam Salimi
29. Fernando Almeida
30. Flávia Barbosa
31. Gonçalo Figueira
32. Gustavo Dalmarco
33. Helio Castro
34. Hermilio Carneiro Vilarinho Fernandes
35. João Alberto Vieira de Campos Pereira Claro
36. João Augusto de Sousa Bastos
37. João Falcão e Cunha
38. João José da Cunha e Silva Pinto Ferreira
39. Jorge Daniel Grenha Luís Teixeira
40. Jorge Manuel Pinho de Sousa
41. Jose Fernando da Costa Oliveira
42. José Luís Cabral de Moura Borges
43. José Manuel de Araújo Baptista Mendonça
44. José Pedro Coelho Rodrigues
45. Kseniia Klimentova
46. Manuel Joaquim Pereira Lopes

47. Manuel Victor Martins de Matos
48. MARIA ANTÓNIA DA SILVA LOPES E CARRAVILLA
49. Maria Beatriz Brito Oliveira
50. Maria do Rosário Mota de Oliveira Alves Moreira
51. Maria Eduarda da Rocha Pinto Augusto da Silva
52. MARIA GABRIELA BEIRÃO DOS SANTOS
53. Maria João Martins dos Santos
54. Mário Filipe Amorim Faria de Oliveira Lopes
55. MARTA MACEDO VRANAS
56. Marta Maria Campos Ferreira
57. Nelson Duarte
58. Patrícia Alexandra Gregório Ramos
59. Paulo António da Silva Ávila
60. Pedro Filipe de Monteiro Rocha
61. Pedro Pinho Senna
62. Pedro Sanches Amorim
63. Raquel Meneses
64. Ricardo Augusto Zimmermann
65. Ricardo Filipe Ferreira Soares
66. Sara Correia Neves
67. Sara Martins
68. Tânia Daniela Lopes da Rocha Fontes
69. Vasco Bernardo Figueiredo Cabral Teles
70. VERA LÚCIA MIGUEIS OLIVEIRA E SILVA

12.2.2 List of Research Group Collaborating Researchers

Analogous to the previous field.

1. Allon Soares da Silva
2. Álvaro José Santos Teles
3. Ana Carolina Marques Chaves
4. Ana Carolina Tavares da Silva
5. Ângelo Emanuel Vieira Soares
6. António Manuel Pinto Correia Alves
7. Carolina de António Ferraz
8. Catarina Coelho Carvalho
9. CÉSAR AUGUSTO MATOS TOSCANO
10. Cristina Barbosa
11. Daniela Silva
12. Fernando José Miranda Carvalhido da Cunha Osório
13. Filipe David Maia Ferreira
14. Filipe Rodrigues Ferreira
15. Giulianna Meléndez Reyes
16. Henrique Gonçalves Piqueiro
17. Inês Pascoal Nogueira
18. Isabela Marques de Miranda
19. Joana Costa
20. João Correia de Araújo

21. João Paulo Ferreira da Silva
22. José António Soeiro Ferreira
23. José Carlos Caldeira Pinto de Sousa
24. Joyce Azevedo Caetano
25. Luís Filipe Maia Carneiro
26. Luís Manuel Fernandes Pereira
27. Luís Miguel Moreira Guardão
28. Maria Alexandra Neves Soares dos Reis Torgal Lobo Xavier
29. Matheus Fernandes Vilhena Campinho
30. Miguel Maio Romariz
31. NUNO MIGUEL FIGUEIREDO SÁ
32. Paulo Sá Marques
33. Pedro Luís Rangel Pinto
34. Philippe Mirault
35. Reinaldo Luís Pinto Silva Gomes
36. Ricardo Migueis
37. RICARDO MIGUEL BARROS FERREIRA
38. Romão Filipe Dias Santos
39. Ruben Monteiro Pereira
40. Rui Diogo Rebelo
41. Rui Luís Correia Dias
42. Sara Dantas de Sousa Pereira
43. Sérgio Vasconcelos Castro
44. SUSANA PAULA BARBOSA DE OLIVEIRA
45. Teresa Couto Viana
46. Tiago Alves
47. Tomás Miguel Barosa dos Santos
48. Verónica Azevedo Ferreira

12.2.3 List of Research Group supervised PhD students

Select the PhD students members of the Research Group, who are supervised by Research Group's Integrated PhD holder Researchers, from the pre-filled list of PhD students identified in 9.3.

1. Alexandra Francisco Ramôa da Costa Alves
2. Alípio José Silva da Torre
3. Ana Inês
4. Armando Teles Dauer
5. Barbara Pisoni Bender Andrade
6. Bianca-Andreea Banica
7. CARMEN CRISTINA DOS SANTOS LIMA
8. CAROLINA PEREIRA PEDROSO
9. Daniela Ferreira Fernandes
10. Eduarda Mano
11. Felipe Tetsuo Yamada
12. Filipa Rente Ramalho
13. HENRIQUE DIOGO CARDOSO DA SILVA
14. Inês Beatriz Pimenta de Sousa
15. Joana Margarida Bôto

16. João Miguel Ramos Chaves Fernandes
17. Juliana Carvalho Cortes Silva
18. Luciana Narumi Oshiro Yamada
19. Marcella Luiza Santos Mendes
20. Mariana Ramos Silvério Casalta
21. Mariana Silva Sousa
22. Mário Joaquim Da Silva Pinto
23. Mayara Emilia Barbosa Souza
24. Nabila Asad
25. Nicolas Clavijo-Buritica
26. Paulo Pereira
27. Raziye Ghanbarifard
28. Sanaâ FINICH
29. Sayeh Fooladi Mahani
30. Sthefan Berwanger
31. Tiago Rafael Pinto Monteiro
32. Vasco Nunes Loureiro Silva