

# Fundação para a Ciência e a Tecnologia

## Evaluation Research Unit 2017/2018

**Document Date:** 2018/02/09

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### Part 1: Identification of the R&D Unit, the Management Institutions and the Participant Institutions

#### 01. IDENTIFICATION OF THE R&D Unit

##### 1.0 Reference

27

##### 1.1 Name of the R&D Unit

Artificial Intelligence and Computer Science Laboratory

##### 1.2 Acronym

LIACC

##### 1.3 Coordinator

Luis Paulo Gonçalves Reis

##### 1.4 Scientific areas

Engineering and Technology Sciences - Electronics, electrical and information engineering

##### 1.5 Keywords

Artificial Intelligence

Computer Science

Multi-Agent Systems

Intelligent Simulation

Declarative and Reliable Programming

##### 1.6 R&D Unit Contacts and Address

•Postal Address:

Praça de Gomes Teixeira  
4099 - 002 Porto

•Nº de telefone:919455251

•Endereço e-mail:dir-liacc@liacc.up.pt

##### 1.7 Link to the R&D Unit's page on the Internet

<https://web.fe.up.pt/~liacc/>

## 02. Evaluation Panel to whom the R&D Unit submits the current application

### 2.1 Evaluation Panel to whom the R&D Unit submits the current application

ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

## 03. Involved institutions

### 3.1 Main Management Institution

Universidade do Porto (UP)

### 3.2 Other(s) Management Institution(s)

### 3.3 Partnership agreements with Management Institution(s)

### 3.4 Participating Institution(s)

### 3.5 Partnership agreements with Participant Institution(s)

#### **Institution Name**

Instituto Politécnico do Porto (IPP)

Faculdade de Engenharia da Universidade do Porto (FE/UP)

Município de Penacova (CMP)

AJCASTRO.COM Consultoria Informática Lda (AJCASTRO.COM)

## 04. Description of the main contributions of the team of Integrated Researchers in the current application

### 4.1 General description of the R&D Unit

Starting in 1988 with joint efforts of 5 PhDs in Computer Science and Artificial Intelligence, LIACC -Laboratory of Artificial Intelligence and Computer Science at the University of Porto, has been reconfigured several times along the last 30 years. From the 5 pioneers, only one is still active at LIACC. However, throughout the years, LIACC attracted researchers from several Universities and Institutes, including mostly several young and very promising researchers. In January 2018, LIACC includes 19 integrated PhD members, including 10 recent PhDs (with doctoral degrees achieved in the last 6 years). Since LIACC is a small research unit, it also includes a large amount of collaborators, typically from larger research units for enabling joint research work on large projects. LIACC researchers mainly belong to the Faculty of Engineering and the Faculty of Sciences of the University of Porto. However, several researchers are connected with other institutions such as the Polytechnic Institute of Porto and several other private and public institutions. Most of the researchers holding a PhD are not doing full-time research, since they are University Professors and have heavy involvement in lecturing (between 8 and 12 hours per week).

LIACC includes three different groups: DAIAS - Distributed Artificial Intelligence and Agent-based Simulation, HMIC - Human-Machine Intelligent Cooperation and CS - Computer Science. Management of LIACC is done according to the FCT Multi-year Funding Program rules through a Coordinating Board, a Scientific Council and an external Advisory Board. The Coordinating Board is composed of four senior researchers, one of which is the Director. The Scientific Council, responsible for the approval of annual reports and plans, is composed by all the researchers holding a PhD. Activities are periodically reviewed by an external Advisory Board. On January 2018, the following LIACC members belong to the Coordinating Board: Luís Paulo Reis (Director), Ana Paula Rocha, Rosaldo Rossetti and António Porto. The Advisory Board is composed by: Carles Sierra (IIIA, CSIC, Barcelona), Claude Kirchner (INRIA, France) and as new members Marco Dorigo (Universite' Libre de Bruxelles, Belgium) and Helder Coelho (Univ. Lisbon). The existing groups have some differences regarding research methods, sensibility and scientific areas. While DAIAS and HMIC groups, mainly located at the Faculty of Engineering, are more concerned with applied and problem-oriented research usually leading to modeling and prototyping, the CS group, mainly located at the Faculty of Sciences, is more devoted to theoretical research. All the groups are also heavily involved in post-graduation students' supervision and knowledge transfer. DAIAS group pursues mainly research on Distributed AI with research lines concerned with MAS and agent-based interoperability for networking and cooperation, agent-based simulation, text mining, and cloud, parallel computing and applications. For CS group, the main general aim is software and information processing reliability. The HMIC group is primarily concerned with human factors of computing and machinery systems and focuses on creating methodologies that enable machines and software systems to think and interact like humans.

LIACC's research areas traditionally publish mainly in conferences, which, in many cases, are tougher (or at least as tough) regarding the reviewing process than many journals. However, we tried to curb our flow of publications a bit more for the international journals. LIACC members have often also privileged software demos and participation in competitions for the sake of showing the current performance of some of the outcomes. LIACC, as a whole, meets once a

year for a "brainstorming" about current and future research directions. LIACC, in time period 2013-17, has produced a very good number of relevant publications (with over 400 publications in international journals and conferences).

4.2 Identification and brief description of up to 5 contributions the R&D Unit considers most important of those provided in period 2013-2017 by Integrated Researchers registered in the current application, independently of the R&D Unit having existed or not

## Agent-Based Modelling and Simulation

In the last years, LIACC has worked towards the consolidation of impact research on "Complex Systems Analysis and Engineering", whose main characteristics rely on computer modeling and simulation to analyze and propose solutions to various application domains. Mostly, LIACC gives special attention to the specific field of Agent-Based Modelling and Simulation (ABMS), contributing to both theory and practical applications in this important field of Computer Science. Intelligent Transportation Systems and all related areas of mobility systems have been one of the major application domains on which LIACC focuses its ABMS research. Some important prototypes and test-beds have been implemented and improved over the years, namely the TraSMAPI agent framework to implement AI-based traffic control and management policies on top of a diverse range of traffic simulators; the Autonomous Driving simulator environment, combining a robotics simulator and a microscopic traffic simulator to analyse and test with autonomous vehicles; a framework to infer mobility patterns from Social Media contents - in this specific case, Twitter messages have been used; the SPEED framework and methodology for pedestrian simulation has been extended and improved to support the concept of Serious Games and gamification. The aforementioned contributions are all part of the MAS-Ter Lab platform (standing for Multi-Agent Systems applied to Transport engineering and research) that integrates different tools, processes, and methodologies to devise, test and implement state-of-the-art intelligent transportation systems and smart mobility solutions. MAS-Ter Lab is built on the grounds of important technologies, namely HPC, Data Mining, Stream Data, distributed simulation, and social networks. Most recently, MAS-Ter Lab has served as the reference architecture to support the implementation of NEXT, an integrated traffic management system implemented in collaboration of ARMIS Group, CMP (Porto City Council), STCP, and IP. A pilot prototype of NEXT has been deployed at CMP and is currently under evaluation, allowing it to be benchmarked against current solutions implemented at CMP, namely the Gertrude Traffic Management System. Also, LIACC has joined ARMIS Group and Caetano Bus to implement the intelligence underneath the autonomous bus architecture under development by Caetano Bus. Given its accumulated experience in engineering, testing, and implementing Intelligent Transportation Systems, LIACC joined the C-ROADS Portugal platform, consisting of different stakeholders pursuing the implementation of the integrated cooperative transport system across Europe and leveraging better and smarter services to all classes of transport users in Portugal. This line of research originated also the participation of LIACC/UP in the ongoing H2020 project SIMUSAFE (SIMULATION of behavioral aspects for SAFER transport - <http://simusafe.eu/>).

## Multi-Agent System for Disruption Management

LIACC researchers developed a sophisticated and complete Multi-Agent System for Disruption Management, suitable to be applied to distributed problems where traditional sequential approaches are not sufficient. In this research, we addressed several issues related with distributed, dynamic and decentralized problems: multiple cooperation in obtaining solutions from multiple perspectives; monitoring the operational plan and deciding if an event requires or not a corrective action; learning from experience and from human interaction; and, which makes it more easily acceptable to potential users, the interaction with human-in-the-loop decision makers.

Major results from this line of research include a prototype (MASDIMA) and a proof of concept in a real environment that has been performed at TAP Air Portugal, where the approach was tested in parallel with TAP systems. Other major outcomes include a Ph.D. Thesis that was awarded the best Portuguese AI thesis award (from APPIA), and a book entitled A New Approach for Disruption Management in Airline Operations Control, published by Springer in 2014, among several other publications in international conferences and journals. MASDIMA also gave rise to a spin-off company located at the Technology and Science Park of the University of Porto.

#### Non-Parametric Contextual Stochastic Search and RoboCup

LIACC has been researching in continuous black-box optimization and developed a battery of new, state-of-the-art algorithms to tackle continuous black-box optimization problems. We developed two new algorithms: Trust Region Covariance Matrix Evolution Strategy (TR-CMA-ES) and Model-Based Relative Entropy Stochastic Search (MORE). Stochastic search algorithms aim at repeating the type of mutations that led to the best search points in a population. We can model those mutations by a stochastic distribution and typically, the stochastic distribution is modeled as a multivariate Gaussian distribution. The key idea is to iteratively change the distribution parameters towards higher expected fitness. However, we leverage information theoretic trust regions and limit the change of the distribution. Being derived from first principles, our approach can be elegantly extended to contextual learning setting, which allows for learning context dependent stochastic distributions that generates optimal individuals for a given context, i.e, instead of learning one task at a time, we can learn multiple related tasks at once and exploit the correlations between related tasks. However, the search distribution typically uses a parametric model that is linear in some hand-defined context features. Finding good context features is a challenging task, and hence, non-parametric methods are often preferred over their parametric counterparts. Therefore, we further propose a non-parametric contextual stochastic search algorithm that can learn a non-parametric search distribution for multiple tasks simultaneously.

This line of research conducted to publication in several main conferences of the area (IROS, IJCAI, GECCO(3) - best paper candidate in 2017, NIPS, IEEE ICARSC - best paper award) and several journals (such as JINT from Springer). The work was also applied in the FC Portugal robotic soccer team for the optimization of low-level and mid-level robot skills and helped FC Portugal team to achieve 10 international awards including the winner of RoboCup scientific/free challenge in both 2013 and 2015.

4.3 Main publications in 2013-2017 authored by Integrated Researchers registered in the current application

Reference	URL
Abbas Abdolmaleki, Nuno Lau, Luis Paulo Reis, Jan Peters, Gerhard Neumann, Contextual Policy Search for Linear and Nonlinear Generalization of a Humanoid Walking Controller, Journal of Intelligent and Robotic Systems: Theory and Applications, Springer, Vol.83, Issue: 3/4, pp. 393-408, Springer, September 2016, DOI: 10.1007/s10846-016-0347-y	<a href="https://web.fe.up.pt/~liacc/publications/LIACC_Publication1_JINT_Journal_2016.pdf">https://web.fe.up.pt/~liacc/publications/LIACC_Publication1_JINT_Journal_2016.pdf</a>
Lúcio S. Passos, Rui Abreu, Rosaldo J. F. Rossetti, Empirical Evaluation of Similarity Coefficients for Multiagent Fault Localization, IEEE Transactions on Systems, Man and Cybernetic: Systems, Volume 47, Issue 5, Pages 767-782, May 2017, DOI: 10.1109/TSMC.2016.2523905	<a href="https://web.fe.up.pt/~liacc/publications/LIACC_Publication2_IEEETransSMC_Journal_2017.pdf">https://web.fe.up.pt/~liacc/publications/LIACC_Publication2_IEEETransSMC_Journal_2017.pdf</a>
Steffen Jost, Pedro B. Vasconcelos, Mário Florido, Kevin Hammond, Type-Based Cost Analysis for Lazy Functional Languages. Journal of Automated Reasoning, Volume 59, Issue 1, Pages 87-120, 2017, DOI: 10.1007/s10817-016-9398-9	<a href="https://web.fe.up.pt/~liacc/publications/LIACC_Publication3_JAR_Journal_2017.pdf">https://web.fe.up.pt/~liacc/publications/LIACC_Publication3_JAR_Journal_2017.pdf</a>
Hamid Arabnejad, Jorge G. Barbosa, Multi-QoS Constrained and Profit-Aware Scheduling Approach for Concurrent Workflows on Heterogeneous Systems, Future Generation Computer Systems Journal, Elsevier B.V., Volume 68, Pages 211-221, March 2017, DOI: 10.1016/j.future.2016.10.003	<a href="https://web.fe.up.pt/~liacc/publications/LIACC_Publication4_FGCS_Journal_2017.pdf">https://web.fe.up.pt/~liacc/publications/LIACC_Publication4_FGCS_Journal_2017.pdf</a>
Abbas Abdolmaleki, Bob Price, Nuno Lau, Luís Paulo Reis, Gerhard Neumann, Contextual Covariance Matrix Adaptation Evolutionary Strategies, IJCAI - International Joint Conference on Artificial Intelligence, Pages 1378-1385, 2017	<a href="https://web.fe.up.pt/~liacc/publications/LIACC_Publication5_IJCAI_Conf_2017">https://web.fe.up.pt/~liacc/publications/LIACC_Publication5_IJCAI_Conf_2017</a>

4.4 Description of other relevant contributions resulting from the activities in 2013-2017 of Integrated Researchers registered in the current application

## Type Theory and Type Systems for Programming Languages

In LIACC the focus of research in type theory is related to programming language design and implementation, where type systems have an important role in modern programming languages as a module in the compilation process to avoid or reduce bugs. We made significant contributions in the area, mostly in the definition of novel type systems for statically determining the execution costs of programs. In this area, we have successfully supervised five Ph.D. thesis and published papers in major conferences such as ICFP or ESOP and major journals (such as the J. of Automated Reasoning, J. TPLP and the J. of Functional Programming). LIACC was also a member of top international research networks in the area such as the European COST actions TACLe and EUTYPES (network management committee). In the last years, this research group also addressed new problems arising from emergent areas such as Web programming by using types to detect inconsistencies in Web programming. With this motivation, LIACC is the principal research unit in a multi-disciplinary project financed by FCT (Elven - PTDC/EEI-CTP/3506/2014), where the goal is exactly verification of web programming.

## Multi-QoS and Profit Aware Scheduling

Computing systems are complex due to the heterogeneity that characterizes current computing nodes. To obtain efficient systems one needs to resort to sophisticated scheduling and resource management algorithms that can run a given program, or a set of concurrent programs, efficiently and by introducing low overhead. In this context, we have developed several scheduling algorithms for heterogeneous systems, where jobs are represented by workflows. For single job scheduling, we have developed Predict Earliest Finish Time (PEFT), with quadratic complexity that implements a look-ahead feature and outperforms higher complexity algorithms. It is a breakthrough of this type of algorithms because the look-ahead feature was only available at a higher computational complexity. The utility model, commonly used today, implies that a job runs under certain constraints. We have developed the Deadline-Budget Constrained Scheduling (DBCS) algorithm that is able to find a scheduling solution in just 4% of the time and with equivalent performance of other higher complexity algorithms. This is an important result due to the performance obtained with a low overhead algorithm. Concerning concurrent job scheduling on a heterogeneous system, we have developed Multi-QoS and Profit Aware Scheduling (MQ-PAS) that is able to obtain a similar success rate while increasing the providers' profit. These algorithms are of major relevance in a current H2020 project addressing scalable services at exascale computing.

## Text Mining and Argument Mining

A line of research in TM (Text Mining) within LIACC is related with the development of methods to extract, retrieve and predict entity-centric information spread across the web with application to Online Reputation Monitoring (ORM). More specifically, we tackled the problem of Entity-Relationship Retrieval in which the goal is to search for multiple connected entities. We also tackled Financial Sentiment Analysis and participated in SemEval 2017 Task 5, obtaining state-of-the-art performance. Finally, we created and released an adaptable Entity Retrieval and Text Mining framework for multiple application scenarios, from computational journalism to politics and



finance. We also developed methods and tools argumentation mining (AM) and build the first AM corpus for Portuguese and a framework for AM (ArgMine). We have also addressed NLP tasks that are relevant for AM, including coreference resolution and recognizing textual entailment and explored state-of-the-art ML algorithms. We are also coordinating the Argumentation Hub (ARGH), a collaborative lab including researchers from several faculties and areas.

## Part 2: Description of the R&D Unit, main contributions of the team of integrated researchers in the application and funding in 2013-17

### 05. Reports and membership of External Advisory Board

#### 5.1 External Advisory Board reports in 2013-2017

<b>R&amp;D Unit</b>	<b>File</b>
LIACC	Advisory_Board_Report_LIACC.pdf

#### 5.2 Current External Advisory Board membership

<b>R&amp;D Unit</b>	<b>Member Name</b>	<b>Institution</b>
LIACC	Carles Sierra	Artificial Intelligence Research Institute (IIIA) - Spain
LIACC	Claude Kirchner	Centre de Recherche INRIA - France

#### 5.3 External Advisory Board membership

<b>Member Name</b>	<b>Institution</b>
Hélder Coelho	Universidade de Lisboa - Portugal
Marco Dorigo	Universite' Libre de Bruxelles - Belgium
Carles Sierra	Artificial Intelligence Research Institute (IIIA) - Spain
Claude Kirchner	Centre de Recherche INRIA - France

### 06. Funding in 2013-2017

#### 6.1 Annual funding in 2013-2017

FUNDING SOURCES (TOTAL FUNDING)	2013	2014	2015	2016	2017	TOTAL (K€)
<b>Fundação para a Ciência e a Tecnologia, I.P. - FCT</b>	300	260	280	350	380	1.570
R&D Unit Pluriannual funding	70	50	50	50	50	270
Project funding	80	60	60	120	150	470
Funding for contracts of researchers with PhD (1)	0	0	0	0	0	0
Funding for PhD, PostDoc or other fellowships (2)	150	150	170	180	180	830
Other funding	0	0	0	0	0	0
<b>Other national sources</b>	10	15	40	40	60	165
Funding received from Participant or Management Institutions	0	0	0	0	0	0
Public sources (3)	0	0	0	0	0	0

Companies, industry and other private sources based in Portugal (3)	10	15	40	40	60	165
Any other funding source (3)	0	0	0	0	0	0
<b>International sources</b>	170	130	205	195	235	935
European Commission (3)	120	80	150	150	180	680
Companies, industry and other private sources not based in Portugal (3)	20	20	25	30	40	135
Other funding sources (3)	30	30	30	15	15	120
<b>Total (K€)</b>	480	405	525	585	675	2.670

(1) Payed through an institution or directly to researchers with PhD integrated in the R&D Unit

(2) Payed directly to fellows, researchers or students integrated in the R&D Unit

(3) Grants, projects, fellowships, prizes received, etc

## 07. Integrated Researchers, PhD students and research contracts in 2013-2017

### 7.1 Total numbers of Integrated Researchers, PhD students and research contracts in 2013-2017

Researchers and students	2013	2014	2015	2016	2017
No. of integrated researchers	35	35	35	35	35
No. of Integrated researchers with PhD	23	23	23	23	23
No. of PhD students advised by integrated members of the R&D Unit	25	25	25	25	25
No. of research contracts with national public or private entities	5	6	6	7	7
No. of research contracts with international bodies	5	6	6	7	7

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

### 08. Lists of researchers in the current application

#### 8.1 List of the Integrated Researchers of the R&D Unit who hold a PhD degree

Name	Nuclear CV	ORCID iD
Luis Paulo Gonçalves Reis	Yes	0000-0002-4709-1718
Altino Manuel Silva Sampaio	No	0000-0002-9019-4333
Ana Paula Cunha da Rocha	No	0000-0002-8129-9758
António Beça Gonçalves Porto	No	0000-0002-5747-5512
António Jesus Monteiro de Castro	No	0000-0001-8121-1974
António Mário Silva Marcos Florido	No	0000-0002-0574-7555
armando barbot campos matos	No	0000-0003-2144-4439
Brígida Mónica Teixeira de Faria	No	0000-0003-2102-3407
Daniel Augusto Gama de Castro Silva	No	0000-0001-9293-0341
Eugenio da Costa Oliveira	Yes	0000-0001-9271-610X
Filipe Alexandre Almeida Ningre de Sá	No	0000-0002-7846-8397
Henrique Daniel de Avelar Lopes Cardoso	No	0000-0003-1252-7515
João Tiago Pinheiro Neto Jacob	No	0000-0003-2078-3375
Jorge Manuel Gomes Barbosa	No	0000-0003-4135-2347
Jorge Manuel Neves Coelho	No	0000-0002-3395-6426
Luís Filipe Guimarães Teófilo	No	0000-0002-2961-4757
Pedro Baltazar Vasconcelos	No	0000-0002-8387-9772
Pedro Gonçalo Ferreira Alves Nogueira	No	0000-0002-9646-8438
Rosaldo José Fernandes Rossetti	Yes	0000-0002-1566-7006

## 8.2 List of the Integrated Researchers of the R&D Unit who do not hold a PhD degree

Name	Is PhD Student?	ORCID iD
AlexandraAlves Oliveira	Yes	0000-0001-5872-5504
Álvaro Luiz Panarra das Neves Câmara	Yes	0000-0001-7834-3351
Elis Regina silva	Yes	0000-0002-2779-2488
Gil Filipe da Rocha	Yes	0000-0001-8252-7292
João Francisco Carvalho Neto	Yes	0000-0003-0755-9694
Jonas Felipe Pereira de Queiroz	Yes	0000-0001-5416-4762
Thiago Reis Pedroso Munhoz Rúbio	Yes	0000-0001-7450-8075
Zafeiris Kokkinogenis	Yes	0000-0002-0247-4184

### 8.3 List of the Collaborator Researchers of the R&D Unit

Name	ORCID iD
abbas abdolmaleki	0000-0002-1796-0097
Álvaro Manuel reis da Rocha	0000-0002-0750-8187
António Pedro Dias da Costa	0000-0002-4644-5879
Armando Jorge Miranda de Sousa	0000-0002-0317-4714
CÉLIA TALMA MARTINS DE PINHO VALENTE	0000-0002-3861-0854
César José Cardoso Ferreira	0000-0003-1779-7848
Christophe Pinto de Almeida Soares	0000-0002-0382-879X
Cláudio Oliveira Amaral	
Cristina Manuela Peixoto dos Santos	0000-0003-0023-7203
David Joao Apolinario Simoes	0000-0002-6464-8012
Diogo Ribeiro Gomes dos Santos	0000-0002-6697-7477
Francisco José de Oliveira Restivo	0000-0002-6173-082X
João Alberto Fabro	
João Carlos Vieira Peixoto André	0000-0002-3666-4453
João Emílio Santos Carvalho de Almeida	
João Ferreira de Carvalho Castro Nunes	0000-0002-5204-4043
João Luís Alves Barbosa	
Joaquim Fernando Fernandes da Silva	
Joaquim José de Almeida Soares Gonçalves	0000-0003-2219-1816
José Manuel de Castro Torres	0000-0002-8280-1324
José Nuno Pannels Nunes Lau	0000-0003-0513-158X
Marcelo Roberto Petry	0000-0002-7023-8562
Maria Benilde oliveira Lopes	
Maria Dulce Fernandes Mota	
Maria Joana Malaquias Pires Urbano	0000-0002-1156-9329
Nelson Ricardo Martins Rodrigues	0000-0001-7986-3754
Patrícia Isabel Sousa Trindade da Silva Leite	0000-0002-6678-3912
Paula Alexandra Carvalho de Sousa Rego	0000-0001-8188-1804
Paulo adriano Marques Sousa Teixeira	
Paulo José de Albuquerque Cardoso Trigueiros	0000-0001-6878-2123
Pedro dos Santos Saleiro da Cruz	

Pedro Manuel Henriques da Cunha Abreu	0000-0002-9278-8194
Pedro Miguel Alves Sobral	
Pedro Miguel Carvalho da Silva	
Pedro Miguel do Vale Moreira	0000-0001-8371-0347
Pedro Ricardo da Nova Valente	0000-0003-2766-909X
Rui Jorge da Silva Moreira	0000-0002-4123-0983
Rui Jorge Santos Andrade	
Simão Patrício Melo de Sousa	0000-0001-9129-4136
Simão Paulo Rato Alves Reis	
Tiago Luís Pacheco Neto	
Tiago Manuel Lourenço Azevedo	

## 09. PROPOSED RESEARCH GROUPS

The minimum number of confirmed integrated researchers in order to fill research groups information is 50 and you have only 19.

## Part 4: Plan of Activities for 2018-2022

### 10. Summaries of the Plan of Activities for 2018-2022

#### 10.1 Summary in Portuguese for general dissemination purposes



O LIACC é uma unidade de investigação localizada essencialmente nas Faculdades de Engenharia e Ciências da Universidade do Porto, embora inclua membros de diversas outras Instituições. Inclui 19 membros doutorados integrados, 20 alunos de doutoramento e 31 outros colaboradores. A gestão do laboratório é realizada de acordo com as regras do Programa de Financiamento Plurianual da FCT, através de um Conselho Coordenador, um Conselho Científico e um Conselho Consultivo Externo. Os objetivos gerais do LIACC para 2018-2022 dividem-se em três classes: 1) Contribuir para a investigação em: a) Sistemas de software distribuídos e descentralizados; b) Extração de conhecimento e informação; c) Cooperação inteligente homem-máquina; d) Simulação Inteligente de Sistemas Complexos; e) Programação declarativa para sistemas mais seguros. 2) implementar sistemas como provas de conceitos levando à criação de protótipos e futuras aplicações. 3) Supervisionar o trabalho de investigação conducente a doutoramentos e mestrados nos temas acima mencionados. Seguindo essas linhas, o LIACC produz software e protótipos apoiados por publicações relevantes, além de ajudar jovens investigadores no desenvolvimento das suas teses. Para cumprir os objetivos gerais mencionados, a investigação do LIACC será centrada nas atividades principais da unidade, ajustada aos novos desafios de uma sociedade em rápida evolução e com a generalização da utilização de técnicas de Inteligência Artificial em sistemas utilizados no dia a dia. Outro objetivo é a automatização da decisão inteligente, não só para agentes individuais e seres humanos, mas também em redes e equipas, em ambientes distribuídos. Defendemos, também, a necessidade de esforços teóricos no desenvolvimento de métodos, na sua maioria do tipo declarativo, para levar do modelo à implementação. Para implementar o seu programa estratégico, o LIACC organiza-se em três grupos: DAIAS - Inteligência Artificial Distribuída e Simulação baseada em Agentes, HMIC- Cooperação Inteligente Homem-Máquina e CS- Ciência de Computadores. A investigação prevista é apoiada por um nível de publicação elevado e muito boa visibilidade na comunidade internacional com mais de 400 publicações para o período 2013-2017. O LIACC continuará envolvido na gestão de programas de doutoramento e supervisão de trabalhos de investigação conducentes a trabalhos de tese. Nos últimos anos, um total de 30 teses de doutoramento e 150 de mestrado foram supervisionadas por membros do LIACC, estando o atualmente 20 teses de doutoramento em curso sob supervisão. O LIACC acredita que a visibilidade e alcance dos seus projetos mais significativos atrairá um número crescente de estudantes de doutoramento, altamente motivados, em Portugal e no exterior. Acreditamos também estar no caminho certo para contribuir com investigação sólida nas áreas da Inteligência Artificial e Ciência de Computadores para ajudar a tornar a tecnologia mais inteligente, sustentável e segura.

## 10.2 Summary in English for general dissemination purposes

LIACC is a research unit located essentially in the Faculties of Engineering and Sciences of the University of Porto, although it includes members of several other Institutions. It includes 19 integrated PhD members, 20 PhD students and 31 other collaborators. Management of LIACC is done according to the FCT Multi-year Funding Program rules, through a Coordinating Board, a Scientific Council, and an external Advisory Board. LIACC general objectives for 2018-2022 are three-fold: 1) To contribute to the research on a) Distributed and decentralized software systems and tools; b) Text mining and Information extraction; c) Human-machine intelligent cooperation; d) Intelligent Simulation of complex systems; e) Declarative software programming enabling safer systems. 2) To implement proof-of-concept software and systems leading to possible prototypes and future real applications. 3) To supervise research work leading to PhD and MSc theses on the aforementioned topics. Following these lines, LIACC aims at producing both software algorithms and prototype systems backed by relevant publications, while also assisting young researchers in developing their theses. In order to fulfill the aforementioned general objectives, LIACC research will be centered in the core activities of the unit, adjusted to the new challenges of a rapidly evolving society with emphasis on the generalization of the use of Artificial Intelligence techniques in systems used on a daily basis. Intelligent decision-making for individual agents but also in networks and teams, in distributed environments, including artificial (agents, robots) and humans is a major aim of the unit. We also advocate the need for more theoretical efforts on developing methods, mostly declarative-type of programming based, for better matching software models and architectures. In order to implement the strategic programme, LIACC is organized in three research groups: DAIAS- Distributed Artificial Intelligence and Agent-based Simulation, HMIC - Human-Machine Intelligent Cooperation and CS - Computer Science. The research envisaged is supported by a strong and publication record and very good visibility in the international community confirmed by consulting the scientific databases (SCOPUS, Web of Knowledge) which include more than 400 LIACC publications for the 2013-2017 period. LIACC will continue focusing on chairing PhD programmes and supervising research work leading to PhD and MSc theses. In the last years, a total of 30 PhD theses and 150 MSc Thesis were supervised by LIACC members and 20 ongoing PhD theses. In this context, we believe that visibility and outreach of our most significant projects will attract an increasing number of, highly motivated, PhD students in Portugal and mostly abroad. We believe we are on the right track to contribute with solid research on Artificial Intelligence and Computer Science that may help to make our technology more intelligent, sustainable and secure.

### 10.3 Summary in English for evaluation

LIACC is a small research unit located essentially in the Faculties of Engineering and Sciences of the University of Porto, although it includes members of several other Institutions. It includes 19 integrated PhD members, 20 PhD students and 31 other collaborators. Management of LIACC is done according to the FCT Multi-year Funding Program rules, through a Coordinating Board, a Scientific Council, and an external Advisory Board. LIACC general objectives for 2018-2022 are three-fold: 1) To contribute to the research on a) Distributed and decentralized software systems and tools; b) Text mining and Information extraction; c) Human-machine intelligent cooperation; d) Intelligent Simulation of complex systems; e) Declarative software programming enabling safer systems. 2) To implement proof-of-concept software and systems leading to possible prototypes and future real applications. 3) To supervise research work leading to PhD and MSc theses on the aforementioned topics. Following these lines, LIACC aims at producing both software algorithms and prototype systems backed by relevant publications, while also assisting young researchers in developing their theses. In order to fulfill the aforementioned general objectives, LIACC research will be centered in the core activities of the unit, adjusted to the new challenges of a rapidly evolving society, of the technological development, of the proliferation of networked devices, of a world where we all simultaneously are information producers and consumers and the generalization of the use of Artificial Intelligence techniques in systems used on a daily basis. Intelligent decision-making for individual agents but also in networks and teams, in distributed environments, including artificial (agents, robots) and humans is a major aim of the unit. We also advocate the need for more theoretical efforts on developing methods, mostly declarative-type of programming based, for better matching software models and architectures. In order to implement the strategic programme, LIACC is organized in three research groups: DAIAS- Distributed Artificial Intelligence and Agent-based Simulation, HMIC - Human-Machine Intelligent Cooperation and CS - Computer Science. DAIAS group includes 9 integrated members and pursues research on multi-agent systems and agent-based interoperability for networking and cooperation; agent-based simulation; Text mining; Cloud, parallel computing and applications. CS group includes 5 integrated members. Its main general aim is software and information processing reliability with emphasis on fundamental research, ranging through computational complexity, automata and formal languages, algorithms, programming languages, semantics, and formal verification. HMIC includes 5 integrated members. The group is primarily concerned on creating methodologies that enable machines and software systems to think and interact like humans and have social capabilities similar to humans enabling them to be members of heterogeneous human/machine teams. The research envisaged is supported by a strong and incremental publication record and very good visibility in the international community confirmed by consulting the scientific databases (SCOPUS, Web of Knowledge) which include about 350 publications for this period. LIACC will continue focusing on chairing PhD programmes and supervising research work leading to PhD and MSc theses. In the last years, a total of 30 PhD theses and 150 MSc Thesis were supervised by LIACC members. LIACC continues very attractive having 20 ongoing PhD theses supervised by its members. In this context, we believe that visibility and outreach of our most significant projects will attract an increasing number of, highly motivated, PhD students in Portugal and mostly abroad. The unit is also highly laboratory intensive. LIACC strongly invests in conceiving, specifying, modeling and implementing proof-of-

concepts that often culminate in prototypes, products or startup companies. The unit will now focus on exploring its international connections for developing larger joint international Horizon2020 and Iberoamerican projects. Major achievements were also proof-of-concepts that enable LIACC to draw a strategy for the future considering their potential adaptation to important application domains: Plan disruptions management for airlines, facilitators for Enterprises networking, Multi-Robot Coordination framework, Intelligent Wheelchair prototype and Cube for new Information Systems. At the international level, the unit has built a network of personal and institutional contacts in Europe, America and Asia that allows for the exchange of people and of ideas with renowned institutions abroad. Our main intent for the future is to produce research of international standards, attracting and preparing researchers for the challenges of the future. Following our work on the past 30 years, this intent will be fulfilled through the participation in research projects, the organization of MSc and PhD programmes, scientific publications, development of patents and prototypes, demonstrations to potential industrial partners, attraction of young people to scientific research, and all the activities that may contribute to the visibility and outreach of LIACC outcomes. We try to achieve these results through a flexible organization, ready to adapt itself fast and efficiently to the change in demand that is anticipated nowadays. We believe we are on the right track to contribute with solid research on Artificial Intelligence and Computer Science that may help to make our technology more intelligent, sustainable and secure.

## 11. Description of the Plan of Activities for 2018-2022

### 11.1 Objectives and strategy of the R&D Unit for 2018-2022

LIACC looks to the 2018-2022 period as a challenge for its scientific developments since modern societies definitely have entered the "data era" and Artificial Intelligence is now becoming a key technology, which can change the world and, from autonomous driving, space exploration to countering terrorism its huge potential is becoming increasingly visible.

Starting with communications facilities that grow at the highest speed ever, as it took 100 years for the first billion landline telephones to be in use, 10 years for the first billion mobile phones to be reached and just one year for the first billion of "smartphones" to be sold. Besides wireless Communication facilities, available data collections and archives grow at gigantic speed, data clouds storage become huge at low costs and integration of personal and geo-data is increasingly available for everyone. People is ready to both consume and make available large amounts of data, eager to interact through worldwide scale social networks which point to the intensification of investment and research efforts in social media and the web of the future, interoperability and semantics, privacy, visibility and security, social network and big data analysis, recommender systems and online e-business. The field of work of LIACC has always been that of combining scientific and engineering knowledge upon the common ground tool of computer science, multi-agent systems, agreement technologies, team's cooperation and coordination, text and network mining, machine learning, parallelism and related subjects.

What we may foresee for 2018-2022 as LIACC guidelines point to the consolidation of our basic research fields, taking into account the new demands of the exponential increase of data and interacting entities (agents) extracting and using information embedded in that data. Therefore, we will pursue challenging issues related with distributed, decentralized, mobile and cloud-based intelligent decision-making, asking for more flexible software and devices interoperability and heterogeneity, as well as new algorithms and methods capable of coping with huge quantities of data. We will also pursue the development of new and more advanced human-machine interaction and cooperation methodologies with emphasis for its practical applications.

Although LIACC has permanently evolved and adjusted its main focus along the past 30 years, we feel that we may increase our embracement of these more distributed and dynamic approaches and, thus, contribute to the future scenario with our own new ideas, growing from the basic ground we have been building in the past. LIACC groups are the following and will pursue, at least, the topics listed below:

1) DAIAS - Distributed AI and Agent-based Simulation. The group is aiming to study, adapt and apply AI-based algorithms, distributed and decentralized approaches, thus going beyond traditional monolithic systems, and including adaptive features, for the sake of contributing to the research in: web of trust: computational trust and reputation models of entities (agents, services) and their application to networks (enterprises, social); networks active analysis and exploitation; dynamic profiling and clustering of entities in networks, for behavior prediction; generic models for multi-agent systems leading to tools and frameworks for joint work through safe electronic encounters and partners selection by means of rich (and argumentation-based) negotiation processes and accountable electronic contracts; normative environments, including models for the use of incentives to make virtual space for economic activities more credible; evolving MAS-based general solutions for coping with plan disruptions and airport logistics management, considering negotiation over market-available resources and learning with experience; agent-

based intelligent simulation and serious games; application of biological and physical inspired theories in complex and evolvable systems; application of MAS and service-oriented principles in manufacturing and smart grids domains; techniques for dealing with hardware and system software failures or intentional changes within the complex system environment; resilient, reactive schedulers that can survive errors at the node and/or the cluster-level. In conclusion, DAIAS main idea for the future is to contribute for the research on specific aspects of intelligent systems, benefiting from approaches built on distributed and decentralized coordination and cooperation, applying AI-based methods for the sake of knowledge extraction (including text) and to apply those approaches to different real domains.

2) HMIC - Human-Machine Intelligent Cooperation. The group focusses on creating methodologies that enable machines and software systems to think and interact like humans and have social capabilities similar to humans enabling them to be members of heterogeneous human/machine teams. The group is mainly focused on Human-machine intelligent interaction with focus on human-machine and human-robot cooperation; Health information systems and its engineering, management, usability and accessibility; Serious and educational games for human education, rehabilitation/health applications and advanced training; Intelligent and social simulation for creating learning/testing environments for solving the previous problems. In conclusion, HMIC research examines issues in the common area of human-machine interaction and intelligent cooperation, distributed artificial intelligence and problem solving, cognitive and social sciences, and health information systems and technology.

3) CS - Computer Science group. Within the general LIACC aim of software and information processing reliability, CS group has always had an emphasis on fundamental research, ranging through computational complexity, automata and formal languages, algorithms, programming languages, semantics, and formal verification. But at the same time, it has also shown a good record of directing fundamental results towards practical applications. Research is still needed to provide the best methods and tools for designing, building, testing, verifying and adapting reliable and evolutive software systems, in a context of ever-increasing interactivity among agents (human or not). The group's approach to tackle these issues is betting on the adequacy and power of declarative programming, in its logic and functional flavours, to achieve and exploit two major abilities for narrowing the gap between intentions and achievements: to tightly match software architecture to conceptual models of the world, and to significantly simplify reasoning about programs, by both humans and computers. There is a common appreciation and use of declarative programming, i.e. logic and/or functional programming, and a general concern with reliability and effectiveness leading to an interest in testing and verification, supported by research on types that can capture behavioral semantics underlying target program properties. We strongly believe that our approach and strategy for the 2018-2022 period will enable us to contribute with solid research on Artificial Intelligence and Computer Science that may help to make our technology more intelligent, sustainable and secure for future generations.

## 11.2 Organization of the R&D Unit for 2018-2022

LIACC is a research unit mainly located at the University of Porto in its Faculties of Engineering and Sciences, although it includes members of several other Institutions. It includes 19 integrated PhD members, 20 PhD students and 31 other collaborators. Management of LIACC is done according to the FCT Multi-year Funding Program rules, through a Coordinating Board, a Scientific Council, and an external Advisory Board. The LIACC director (Luis Paulo Reis) was previously at the University of Minho but moved to the University of Porto making the Laboratory management a lot easier since now all main members of LIACC are based at Porto.

Management of LIACC is done according to the FCT Multi-year Funding Program rules through a Coordinating Board, a Scientific Council and an external Advisory Board. The Coordinating Board is composed of four senior researchers, one of which is the Director. The Scientific Council, responsible for the approval of the laboratory reports and plans, is composed by all the researchers holding a PhD. Activities are periodically reviewed by an external Advisory Board. On January 2018, the following LIACC members belong to the Coordinating Board: Luís Paulo Reis (Director), Ana Paula Rocha, Rosaldo Rossetti and António Porto. The Advisory Board is composed by: Carles Sierra (IIIA, CSIC, Barcelona), Claude Kirchner (INRIA, France) and as new members Marco Dorigo (Universite' Libre de Bruxelles, Belgium) and Hélder Coelho (Univ. Lisbon).

Both Faculty of Engineering and Faculty of Sciences at the University of Porto made available research laboratories to accommodate the academic staff and the PhD and MSc students involved in LIACC activities. The same happens with other institutions that collaborate with LIACC. Most of the equipment LIACC members are using has been obtained through LIACC funding either directly from annual budget or by means of projects' funding, and it is permanently available at the university labs. All LIACC members have access to the research laboratories at the University of Porto.

LIACC is organized in three research groups: DAIAS- Distributed Artificial Intelligence and Agent-based Simulation, HMIC - Human-Machine Intelligent Cooperation and CS - Computer Science. DAIAS group includes nine integrated members and pursues research on multi-agent systems and agent-based interoperability for networking and cooperation; agent-based simulation; Text mining; Cloud, parallel computing and applications. HMIC includes five integrated members. The group is primarily concerned on creating methodologies that enable machines and software systems to think and interact like humans and have social capabilities similar to humans enabling them to be members of heterogeneous human/machine teams. CS group includes five integrated members. Its main general aim is software and information processing reliability with emphasis on fundamental research, ranging through computational complexity, automata and formal languages, algorithms, programming languages, semantics, and formal verification.

With the recent change on the Portuguese Science Foundation research policies, encouraging new research laboratories in Polytechnic Institutes, several previous LIACC members founded new research laboratories at Polytechnic Institutes in the north of Portugal, with emphasis on the Polytechnic Institute of Bragança, Polytechnic Institute of Viana do Castelo and Polytechnic Institute of Cávado e Ave (Barcelos). With emphasis for the new research lab at the Polytechnic Institute of Bragança, led by Paulo Leitão (previous LIACC member and LIACC directive board member until December 2017) we consider that these spin-off laboratories show the research

training of LIACC members and will enable LIACC researcher to have increasing collaborations.

## 12. Thematic Lines

The minimum number of confirmed integrated researchers in order to fill thematic lines information is 100 and you have only 19.

## 13. Ethical issues

### 13.1 Ethical issues

N/A

## 14. Aspects of the Plan of Activities involving requests of Programmatic Funding

### 14.1 Pluriannual plan for PhD fellowships to be awarded in 2019-2022



NAME OF THE PHD PROGRAM	INSTITUTION	DATE OF ACCREDITATION	PRESENTLY FUNCTIONING	R&D UNIT INVOLVEMENT/ CONTRIBUTION OF PHD RESEARCHERS/SCOPE OF THE WORK	2019	2020	2021	2022	NO. OF EXPECTED FELLOWSHIPS
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<p>PRODEI - Doctoral Program in Informati cs Enginee ring</p>	<p>Faculty of Enginee ring of the Universit y of Porto</p>	<p>2014</p>	<p>Yes</p>	<p>LIACC has been the main responsi ble for this Ph.D. program . Eugénio Oliveira (previou s director of LIACC) was director of PRODEI - Doctoral Program in Informati cs Enginee ring since its start. Sixty eight (68) Phd thesis have been defende d at PRODEI since its start.</p>	<p>4</p>	<p>4</p>	<p>4</p>	<p>4</p>	<p>16</p>
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MAP-I - Doctoral Program in Computer Science	Universities of Porto and Aveiro / CMU	2014	Yes	LIACC is involved at MAP-I scientific council and several LIACC researchers lecture courses and are supervising MAP-I students . This year MAP-I lectures took place at FEUP with LIACC researchers deeply involved in this Ph.D. course. LIACC director (Luis Paulo Reis) was plenary speaker at the	2	2	2	2	8
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ce of  
MAP-I  
and  
PRODEI  
students  
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web.fe.u  
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18/index  
.html](https://web.fe.up.pt/~prodei/dsie18/index.html))  
that had  
as main  
chair  
LIACC  
previous  
director  
(Eugeni  
o  
Oliveira)

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PhD in Applied Artificial Intelligence	University of Porto (LIACC/FEUP), 2020 IPCA, Several Companies	No	No	Considering the large attention that AI (Artificial Intelligence) is attracting from different industrial fields, LIACC (one of the main research labs on AI in Portugal), together with a polytechnic institute (IPCA - 2Ai Lab) and several key companies, aims to implement an industrial doctoral program focused on	0	2	2	2	6
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as Unity,  
NVIDIA,  
APTIV,  
BOSCH,  
Google  
DeepMind,  
among  
others),  
foster  
novel AI  
concepts,  
services,  
and  
applications.

14.2 Pluriannual plan for hiring new researchers holding a PhD in 2019-2022

NEW RESEARCHERS TO HIRE	2019	2020	2021	2022	Total
No. researchers	1	1	2	2	6

Short description of the type of researchers to hire, their expected added-value to the R&D Unit activities, expected contract duration, conditions of co-responsibility of higher education or research institutions through which the contracts will be awarded, and of the financial and material conditions that still need to be fulfilled.

LIACC intends to hire new researchers holding a Ph.D. for the 2019-2022 period. Since LIACC is a small research unit, with management from the University of Porto, we will limit our budget for hiring new researchers to a maximum of three researchers per year. The researchers to hire will have a Ph.D. and profile connected with the main LIACC activities, with emphasis on Multi-Agent Systems, Intelligent Robotics, Intelligent Simulation, Text/Data Mining, Declarative Programming and connected areas. Their expected added-value to the R&D Unit activities will be mostly on fostering these main research areas of the lab that are underexplored on other Portuguese research labs. Expected contract duration will be between 2 and 5 years depending on the area and researcher. All financial and material conditions that need to be fulfilled will be assured.

#### 14.3 Support for participation in infrastructures or international networks in 2019-2022

LIACC will continue its strategy of pursuing international and competitive project/scholarship funding for participation in infrastructures or international networks and other items that could be requested for Programmatic Funding.

#### 14.4 Other types of support for which the R&D Unit requests Programmatic Funding in 2019-2022

LIACC will continue its strategy of pursuing international and competitive project/scholarship funding for participation in infrastructures or international networks and other items that could be requested for Programmatic Funding.

## 15. Expected funding and budget for 2018-2022 for evaluation purposes

### 15.1 Expected funding of the R&D Research Unit for 2018-2022

FUNDING SOURCES (TOTAL FUNDING)	2018	2019	2020	2021	2022	TOTAL (K€)
<b>Fundação para a Ciência e a Tecnologia, I.P. - FCT</b>	400	540	590	570	570	2.670
R&D Unit Pluriannual funding awarded for 2018	50	0	0	0	0	50
Project funding expected to be received	200	300	350	300	300	1.450
Expected funding for contracts of researchers with PhD (1)	0	90	90	120	120	420
Expected funding for PhD, PostDoc or other fellowships (2)	150	150	150	150	150	750
Other funding	0	0	0	0	0	0
<b>Other national sources</b>	100	100	150	150	150	650



Funding expected to be received from Participant or Management Institutions	0	0	0	0	0	0
Public sources (3)	0	0	0	0	0	0
Companies, industry and other private sources based in Portugal (3)	100	100	150	150	150	650
Any other funding source (3)	0	0	0	0	0	0
<b>International sources</b>	200	260	260	280	280	1.280
European Commission (3)	150	210	210	230	230	1.030
Companies, industry and other private sources not based in Portugal (3)	30	30	30	30	30	150
Other funding sources (3)	20	20	20	20	20	100
<b>Total (K€)</b>	700	900	1.000	1.000	1.000	4.600

(1) Paid through an institution or directly to researchers with PhD integrated in the R&D Unit

(2) Paid directly to fellows, researchers or students integrated in the R&D Unit

(3) Grants, projects, fellowships, prizes received, etc.

## 15.2 Expense budget of the R&D Research Unit in the Main Management Institution for 2018-2022

**Universidade do Porto (UP)**

Expense Budget items	2018	2019	2020	2021	2022	TOTAL (K€)
<b>Human Resources</b>	350	555	635	635	635	2.810
Contracts of researchers with PhD	0	90	120	120	120	450
PhD, PostDoc or other fellowships	350	450	500	500	500	2.300
Contracts of technical or secretarial staff	0	15	15	15	15	60
<b>Researchers external missions</b>	100	100	100	100	100	500
<b>Temporary visiting researchers or consultants</b>	10	10	10	20	20	70
<b>Patents registration and maintenance</b>	10	5	5	5	5	30
<b>Service or product procurement and acquisition</b>	30	10	10	10	10	70
<b>Equipment</b>	60	40	40	30	30	200

<b>Adaptation of facilities and buildings</b>	0	0	0	0	0	0
<b>Other expenses</b>	140	180	200	200	200	920
<b>Total (K€)</b>	700	900	1.000	1.000	1.000	4.600

15.3 Expense budget of the R&D Research Unit in the other Management Institutions for 2018-2022

15.4 Estimated percentages of application by general expense budget items of Base Funding in case it will be awarded by FCT, I.P. for 2018-2022 following the evaluation

Expense Budget items	%
<b>Human Resources</b>	20 %
Contracts of researchers with PhD	10 %
PhD, PostDoc or other fellowships	5 %
Contracts of technical or secretarial staff	5 %
<b>Researchers external missions</b>	30 %

<b>Temporary visiting researchers or consultants</b>	2 %
<b>Patents registration and maintenance</b>	3 %
<b>Service or product procurement and acquisition</b>	5 %
<b>Equipment</b>	20 %
<b>Adaptation of facilities and buildings</b>	0 %

**Other expenses**

20 %

**Total**

100 %

## 16. Justification of the budget for 2018-2022

### 16.1 Justification of the total proposed budget

For 2018-2022, LIACC will significantly increase its activity with new Horizon2020 and Portugal2020 projects and several new projects starting together with industry both in Portugal and abroad. LIACC also expects new FCT research projects approved in the next few months. Although the laboratory mainly uses international/national competitive project/scholarship funding for its activities, with FCT Pluriannual funding awarded representing less than 10% of the global lab funding, the pluriannual funding is critical for several lab activities. These typically include missions of young researchers that are not still participating in any project and thus may not be supported by the lab projects for publishing and presenting their work. In addition, the funding is critical to start new research prospective projects that may not be submitted for funding to other entities before maturing. Equipment is also of utmost importance for the main laboratory activities. Unfortunately, it is very difficult to buy the equipment needed for LIACC main activities, using project funding and thus the lab pluriannual funding is critical on this matter. The funding is also needed for temporary visiting researchers, LIACC advisory board meetings, LIACC global meetings (typically we have a LIACC journey each year), secretariat support and patent registration (mostly in the cases patents are not predicted in a project but the project results exceed expectative and patent registrations are possible). Funding will be also needed for improving LIACC image with new, more professional web pages and image.

### 16.2 Justification of the Human Resources component in total proposed budget

The human resources component in the total budget represent a very large part of the global budget since most Horizon2020, Portugal2020 and FCT (Portuguese National Science Foundation) projects fund mostly human resources. Since LIACC members have also been very active in helping young, promising students to achieve international/national scholarships, we foresee a large number of competitive funding achieved for scholarships in the 2018-2022 period.

### 16.3 Justification of the Equipment component in total proposed budget

The equipment component in the total proposed budget is relatively small mostly due to the difficulty in funding equipment through Horizon2020 and Portugal2020 projects that typically fund human resources as its main components. We foresee that the use of the FCT Pluriannual funding will be of major importance in the first years of the strategic project, in what concerns equipment, mostly to buy new computers and other electronic equipment such as robots, sensors, and actuators. Since the lab develops research in a fast evolving area, the replacement of equipment (such as computers and robots) must be performed regularly to assure the lab may be competitive.

## 17. REVIEWERS PROPOSED BY THE R&D Unit(S)

17.1 Proposed experts for consideration of FCT, I.P. for eventual request of opinion about applications submitted by R&D Units for evaluation

<b>Name</b>	<b>Institution</b>	<b>Email</b>	<b>Scientific Areas</b>
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