Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

Panel Members

Carla P. Gomes (Chair)	Cornell University, United States of America
Alan Macworth	University British Columbia, Canada
David Padua	University of Illinois at Urbana-Champaign, United States of America
Douglas H Fisher	Vanderbilt University, United States of America
Edwina Rissland	University of Massachusetts Amherst, United States of America
Fernando Fernández Rebollo	Universidad Carlos III de Madrid, Spain
Haym Hirsh	Cornell University, United States of America
Keshav Pingali	University of Texas at Austin, United States of America

R&D Units

Centro de Informática e Sistemas da Universidade de Coimbra (CISUC)	Universidade de Coimbra (UC)
Centro de Investigação ALGORITMI (ALGORITMI)	Universidade do Minho (UM)
Centro de Investigação em Gestão de Informação (MagIC)	Instituto Superior de Estatística e Gestão de Informação - NOVA Information Management School (NOVA IMS) (NOVA IMS/UNL)
Centro de Investigação em Informática e Comunicações (CIIC)	Instituto Politécnico de Leiria (IPLeiria)
Computação Cognitiva e Centrada nas Pessoas (COPELABS)	COPELABS - Associação para a Investigação e Desenvolvimento em Cognição e Computação Centrada nas Pessoas (COPELABS)
Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento em Lisboa (INESC-ID)	Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento em Lisboa (INESC ID/INESC/IST/ULisboa)
Instituto de Engenharia Eletrónica e Informática de Aveiro (IEETA)	Universidade de Aveiro (UA)
Laboratório de Inteligência Artificial e Ciência de Computadores (LIACC)	Universidade do Porto (UP)
LASIGE - Extreme Computing (LASIGE)	FCiências.ID - Associação para a Investigação e Desenvolvimento de Ciências (Fciências.ID)
NOVA Laboratory for Computer Science and Informatics (NOVA LINCS)	NOVA.ID.FCT - Associação para a Inovação e Desenvolvimento da FCT (NOVA.ID.FCT/FCTUNL/UNL)

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Centro de Informática e Sistemas da Universidade de Coimbra (CISUC)
Coordinator: Bernardete Martins Ribeiro
Integrated PhD Researchers: 72

Overall Quality Grade: EXCELLENT
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
(B) Merit of the team of Integrated Researchers: 5
(C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 1274 K€
Recommended Programmatic Support
PhD Fellowships: 8
Programmatic Funding: 809 K€, including for 2 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations
This is an excellent proposal from a large, active, and diverse organization whose research interests range from software engineering to computational creativity. The proposal contains good descriptions of past and future research. There is a good record of publications and international activities; there have been several spinoffs. One impressive accomplishment is a system to predict onset of epilepsy seizures; this was a large effort involving large amounts of data and a significant number of patients. Another major area is computational creativity; in this area they have played a strong leadership role. The proposal recognizes that ethical issues are likely to arise in some of their domains of research, like personal healthcare, and takes some steps to deal with them, mostly through proscriptive policies.

Size: CISUC has 72 researchers with PhDs, organized into 6 groups. Groups, and research topics and main accomplishments of each group:
a) Adaptive computation: machine learning, personalized health-care, heterogeneous (CPU/GPU) systems.
Invented new probabilistic graphical models for learning from crowd-sourced data. Papers in ICML, T-PAMI, AAAI HCOMP etc. Best PhD thesis awards from Portuguese AI societies and Oersted postdoc grant from Marie Curie foundation. Led creation of a research network in algorithms for cardiovascular applications. Supported by Philips, Medtronics, H2020. Keynote at Gordon Research Conference Series
Implemented GPUMLib, machine learning library for GPUs (>10K distributions), and EpiLab, open source framework for epilepsy seizure prediction.
b) Cognitive and media systems: visualization, computational creativity (topics at intersection of art and CS such as designing emojis), ambient intelligence (integrating crowd-sourced data in urban environments). Leadership role in Euro 6.5 million FP7 project SOUL-FI on intelligent transport systems. Photogrowth: evolutionary system that creates non-photorealistic ant paintings of photographs. Generated cover image of Leonardo, the 2017 MIT Press catalogue.
c) Communications and telematics: network QOS, IoT, automation and control systems. Built a framework for online detection of anomalies and cyberthreats in industrial and automation control systems. Funded by several EU projects. Two large funded projects on resilience and security in multi-hop 5G networks.
d) Evolutionary and complex systems: approximate and heuristic algorithms for computationally hard problems in multi-objective optimization such as Pareto-front approximation. Invented algorithms with quality guarantees for particular problems in this area. Work “resulted in several publications and an international scientific award.” Open sourced. Bio-inspired algorithms for energy landscapes of chemical aggregates. Large interdisciplinary team from Portugal, Spain, Italy and Brazil.
e) Information systems: game design, sound design, modelling of business processes. Design pattern repository for sound in games: www.soundingames.com
f) Software and systems engineering: fault-tolerance and security of cloud infrastructure, privacy. Several H2020 funded projects.
Belong to SPEC and TPC benchmark organizations. Fault injection tools used by NASA,ESA,Huawei and others. Senior members belong to 104 IFIP Working Group on dependable computing and are on steering committees of conferences in this area.

Funding during 2013-2017: 45 externally funded projects (17 European, 15 FCT, 13 industry/QREN), CISUC funding is 7.8 million euros.

Produced 63 PhDs and 310 MSc students.

In short, the R&D Unit has been very productive and the range of activities is very broad.

All of the research groups and teams are strong. The effort in computational creativity seems particularly novel. Groups 1,2,4,6 have had tangible impact and Group 3 has many funded project and papers.

The Panel got clear and crisp answers to technical questions asked by us during the site visit. The PhD students and postdocs were enthusiastic about their experience in the R&D Unit and in Coimbra, and spoke highly of the quality of mentoring from senior faculty in their areas.

The University of Coimbra has a famous medical school (we were told that it hosts the largest hospital in the Iberian peninsula). Collaborations between CISUC and the medical school and biomedical engineering is growing. This has enabled the CISUC team to perform world-class research on epilepsy seizure prediction, using large data-sets from patients at the hospital.There is an integrated Masters program with biomedical engineering.

In addition to continuing the activities of the 6 groups listed above, the Center proposes three thematic strands: Resilient software and internet systems (RISE), Intelligent systems (IS), and Human-centric computing (HCC). These strands are intended to be cross-cutting but the proposal does not make much of an effort to propose anything really cross-cutting; instead most of what is claimed to be cross-cutting actually repeats the activities of the 6 groups.

RISE will focus on security, dependability and security benchmarking, and experimental dependability evaluation. This is already supported by H2020 ATHMOSFERE project.

Intelligent systems will build on the Pareto-front approximation work in multiobjective optimization from Group 4. H2020 projects like REMAP and LINK will support work in application areas such as diagnosis and prognosis of aircraft systems, and personal health care.

Human-centered computing will continue the work of Groups 2 and 5.

Given the quality of the team, we believe they will do good work but we would have liked to see some real cross-cutting themes because that would lead to better integration of the 6 groups, as noted by the last External Advisory Board report.

The Panel was very pleased with the site visit. They got good and clear answers to questions. The Panel was impressed with the openness of the team members when asked about weaknesses and areas for improvement.

The Unit was well aware of the need for diversity not only with respect to gender and age but also the academic origins of the researchers -- their countries of origins AND their academic institutions. The Panel was impressed that so many students had done their Bachelor's degrees outside of Coimbra - this was very different from the other institutions visited during this evaluation, where they were struck by the degree of the inbreeding both in the student population and in the faculty.

Many faculty and students mentioned that moving to one tower has improved cohesiveness among group members. Previously they were scattered in different buildings, which reduced the degree of cohesiveness. We commend the university and the CISUC group for this move.

The PhD students and postdocs were enthusiastic and smart. Several students mentioned that it was difficult sometimes to get funding to attend conferences in places like the US even when they had papers accepted at those venues, so they said they are now switching to publishing more in journals rather than in conferences. The post-docs however said that publishing in good conferences is always supported by travel grants. Whatever the reality, the Panel wants to emphasize that conference publications are essential for visibility in the CS community. FCT and other organizations may stress journal papers, and publishing in good journals should be encouraged, but this cannot come at the expense of good conference publications. The Panel cannot stress this enough.

The Panel also heard that it is becoming difficult for foreign students to join the PhD program because of the lack of funding, and because of onerous requirements for transferring credits. As mentioned above, the Panel was very positively impressed with the diversity of the current PhD student cohort, and strongly recommends that the university explore ways to reduce the regulatory burden on foreign students. Like other European countries, Portugal has a shrinking population and it seems unfortunate that the University and Government are not doing more to encourage foreign students to study at Coimbra.

During the final session with faculty, several faculty members expressed frustration at how often FCT rules change. The Panel heard this during other site visits as well. The impression is that new governments in Portugal often make major changes in the FCT, and this seems to affect the researchers in universities adversely because of the uncertainty and the difficulty in keeping up with changing policies. The Government of Portugal and FCT should explore ways to fix this problem so Portugal is more in line with other EU countries like France and Germany where this does not seem to be a problem.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Centro de Investigação ALGORITMI (ALGORITMI)
Coordinator: Jose Manuel Ferreira Machado
Integrated PhD Researchers: 101

Overall Quality Grade: VERY GOOD
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 4
(B) Merit of the team of Integrated Researchers: 4
(C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 1493 K€
Recommended Programmatic Support
PhD Fellowships: 3

Justification, Comments and Recommendations
The five most important contributions are good to excellent. There is a lot of applied work. The healthy balance of about 25% basic, 75% applied makes a lot of sense. They are working well with local industry such as polymers and textiles. They have also been working intensively with Bosch - a global company. The Innovative Car HMI is very promising with its two applications: INNOVCAR and iFactory.

The DEM project attacks the areas of health, nutrition, agriculture, activity monitoring, and community tools using ICT.

The PhD program in Advanced Engineering Systems for Industry (AESI) in cooperation with Bosch focuses on advanced engineering systems in industrial applications. It seems to prepare advanced researchers for leading edge industrial research positions, fulfilling an important need.

The partnership with Bosch in the multimedia automotive sector is going well. ALGORITMI researchers were also involved in organizing several international conferences. The major research areas include both core CS and outside area, and the proposal mentions the following areas: industrial electronics, computer science and technologies, computer communications and pervasive media, information sciences and technology, systems engineering, and industrial engineering and management,

ALGORITMI has recently led (in cooperation with IPC - Institute for Polymers and Composites) the creation of the DTx - Digital Transformation CoLab. DTx be a Non-profit Association, with 18 participating entities. It seems to be an exciting applied collaborative venture with a strong future.

The Computer Communications and Pervasive Media (CCPM) group embraces two main areas:
1 - Computer Communications and Networks;
2 - Mobile and Ubiquitous Systems
It has interesting projects in HCI, UX, social and mobile. Non-FCT funding of 19 KEUR per integrated researcher and year seems low, especially since much of the work is industrially relevant.

Computer Science and Technologies (CST) R&D group activities cover a wide range of fundamental and applied research topics related to computer science and technology. The strategic vision of CST focuses in advanced computing technologies and applications. Indeed, the research relies on a set of core scientific areas that provide advanced computing technologies as a means to contribute to the resolution of complex problems in many areas of knowledge and to address important societal challenges. There are four key scientific areas providing computing technologies:
1 - Artificial Intelligence and Intelligent Systems,
2 - Biomedical and Health Informatics.
3 - Language Processing,
4 - High Performance Computing.

Non-FCT funding of 25.8 KEUR per Integrated Researcher per year secured by the Unit seems reasonable. There are 7.2 indexed papers per Integrated Researcher and year. There are good international collaborations and presence at top conferences.

The Industrial Electronics (IE) RG includes 79 researchers (37 PhD and 42 MSc) and is promoted by the Department of Industrial Electronics at the University of Minho. The department works in the area of Electronics and Computer Engineering, offering several teaching programmes in the domain. There are 4.0 papers and articles (indexed) per integrated researcher per year. Non-FCT funding 79 KEUR per integrated researcher per year. Good FP7 projects. Good EU connections.

The Industrial Engineering and Management (IEM) R&D Group includes 108 researchers (54 PhD and 54 MSc), and its focus is on Modelling, Organization and Management of Industrial and Services Systems, covering:
1. Industrial Systems Design & Management
2. Supply-chain Logistics and Transportation Systems
3. Economics and Management of Engineering Systems
4. Ergonomics and Human Factors.
There are 6 indexed papers per integrated researcher per year. There are 26.3 KEUR of non-FCT funded projects per integrated researcher per year; which is low for an applied area. There could be more EU projects. There are good levels of other international activity.

The Information Systems and Technologies (IST) R&D group embraces three main areas:
1 - IST in organizations and in society;
2 - Adaptive and intelligent IST;
3 - Engineering and management of software-based IST.
There are 6.2 indexed papers per integrated researcher per year; it has 42 KEUR of non-FCT funded projects per integrated researcher per year. There are good FP7 projects, with high levels of international activity.

The SEOR group mainly addresses complex engineering systems. The mission is to promote, develop and disseminate quality research in the areas:
1-Linear and Integer Programming (LIP)
2-Nonlinear Optimization
3-Multi-objective (MO) Optimization
4-Mathematical Modeling of Dynamic Systems
5-Applied Statistics.
There are 6.3 publications per integrated researcher per year (50% journals - ratio probably higher than most). There are non-FCT research funds of 19 KEUR per integrated researcher per year, which is low. There are good international activities.

Overall very good quality. Computer Science and Technologies (CST) R&D group is strong. As are the Computer Communications and Pervasive Media (CCPM) Research Group and the Information Systems and Technologies (IST) R&D group.

There are two thematic lines proposed: "Smart Cities and People" and "Innovative Industry and Organizations"

As they describe it: "Smart Cities and People", an interdisciplinary research thematic line, provides the base for the development of innovative technological, economic, social, environmental and wellbeing-related integrated solutions in complex urban centres. It covers scientific models, methodologies and technologies to enhance the human quality of life, leading to healthier, innovative, sustainable and secure societies. Additionally, a growing aging population requires a better understanding of health, wellbeing and disease, focusing on an integrated human-centred health care.

They describe the inter-disciplinary research thematic line "Innovative Industry and Organizations" and say it will do research on current and future challenges of industry and organizations exploring sustainable and social efficiency objectives combining advanced manufacturing processes, smart technologies and knowledge workers.

These are both very good proposals for thematic lines that will stitch together various disciplinary specialties in a variety of coherent projects.

The budget rationale makes sense. It is clear that the Center is under-resourced in terms of administrative support so that researchers are burdened with administrative tasks that could be done better and cheaper by specialised personnel. More open access publication will incur higher costs for page charges and the like. Field experiments in the wild will require more expensive sensors and support.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Centro de Investigação em Gestão de Informação (MagIC)
Coordinator: Fernando José Ferreira Lucas Bação
Integrated PhD Researchers: 28

Overall Quality Grade: VERY GOOD
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 4
(B) Merit of the team of Integrated Researchers: 4
(C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 375 K€
Recommended Programmatic Support
PhD Fellowships: 2

Justification, Comments and Recommendations
The project encompasses four research areas: geoinformatics, data science, information systems, and data-driven marketing. Societal drivers for these areas include smart and open cities, oncologic imaging, land use, and innovation diffusion. These are all worthy areas of research and of application.

The Panel was impressed at the site visit by the level of enthusiasm among all members that, to include leadership, PhD students, junior scientists, and senior scientists. The Panel found that primary strengths of the Center included the following:
1) Increase in young faculty and researchers, and PhD students, in the last 5 years.
2) Scientific output measured by citations and impact shows influence of publications.
3) International collaborations are significant.
4) Within-center collaborations are significant, showing that the Center has responded to earlier Advisory Council recommendation to better integrate across research groups.
5) The center has strong connections to industry, 107 industry partnerships, with funded projects and industry-supported PhD students.

Comments on Five Contributions highlighted by the R&D Unit in the application:

1) Development of partial least squares path modeling and the Portuguese Customer Satisfaction Index has led to significant publications in 2015, one with 1685 citations according to Google.
2) The creation of a Joint Doctorate in Geoinformatics with multiple reputable funding sources and international partners, including University of Munster, University Jaume, and multiple industry partners.
3) Development of a course on Smart Cities and Geospatial Intelligence that is accredited by United States Geospatial Intelligence Foundation.
These are important and innovative educational initiatives with international connections.
4) The development of Geometric Semantic Genetic Programming for supervised learning, with applications to energy consumption, pharmacology, forest biomass, and others. Applications in marine safety and security received best paper awards and the Evostar outstanding contribution award to evolutionary computation.
5) Understanding technology diffusion, notably cloud computing diffusion, including a 2014 paper with 397 citations. Work with Microsoft on Enterprise Resource Planning have led to 10 publications, and the creation of two post-graduate and executive courses.
6) Collaboration with the NOVA medical school have led to a wide variety of important applications ranging from aging and diseases of the aged, food insecurity of the elderly, and 3D modeling the human body with geospatial systems. Other work has received a merit award for medical sciences.

The other contributions by researchers are wide ranging, including to agriculture and higher education, maritime safety and protection, interpolation of climate data, and organization of the 2015 conference of the Association of Geographic Information Systems in Europe (AGILE).

Advanced training includes 15 PhD graduates, 320 Masters, a “best in the world” MS program, 30 seminars including Women in Data Science conference cosponsored with Stanford. There are numerous other programs, notably educational.

The Panel believes that MaGic includes work at the periphery of core computer science research, but that a considerable plurality of the work fits under the broader Information Technologies umbrella. The Center presented rational reasons for having selected the Panel area rather than other Panel areas. The CS topics include evolutionary computation, self-organizing maps, and clustering. Broader representation of machine learning and AI may be an appropriate direction, with submissions to competitive conferences a longer term possibility.

A check of selected researchers, including the Director, show publications in strong venues within the funding period, with the strongest citation record by a Center researcher according to SCOPUS being 1832 overall and 683 within the 2013-2017 period. Two other integrated researchers show reasonable citation records of 153 citations each within the 2013-2017 interval. Other citation records are more modest, but non-zero.

Other projects, highlighted under Criteria A and the application contributions, speak to very good researcher strength.

The broad research areas will remain the same. Geoinformatics will increasingly focus on smart and open cities, where open refers to transparency of government and of the data that emerges from cities. Innovation diffusion will add to cloud computing diffusion, to look at blockchain, IoT, and e-participation. Data science will develop algorithms that can autonomously configure deep learning networks to fit the task. In data-driven marketing, there will be theoretical work on behavioral research with variance-based structural equation modeling to bridge design and behavioral research, and integration of results with health related work with the NOVA medical centers. These are worthy additions to existing research and may bolster the contributions to computer science.

Future work in these areas was not linked overtly linked together, but section 11 outlined a sound plan for collaboration, which may interconnect the research areas to a greater degree. The site visit presentations and follow-up discussions convinced the Panel that integration was occurring and would continue to improve.

The section on ethical issues of the application was empty, but the site visit follow up discussions convinced the Panel that ethical issues were of great concern to the Center and are being addressed responsibly. One of the senior staff will also assume a role on the University’s ethics commission.

22 projects are listed, each with an associated fellowship, with 5 Geo projects (all with fellowships in 2020), 6 data science (4 fellowships in 2019, 1 in 2020, one in 2021), 3 info (1 in 2019, 1 in 2020, 1 in 2022), and 8 in Marketing (2 in 2019, 2 in 2020, 3 in 2021, 1 in 2022).

The projects are at an exceptional level of detail, which helps for understanding the directions towards the center hopes to move.

It is indicated that cloud services will be used rather than purchasing more computers. This conflicts with plans also indicated in the proposal. This apparent inconsistency was not clarified at the site visit because the Panel did not address this question.

The PhD students typically have considerably more industry experience than do students at other institutions, and many continue to work as they pursue their PhD. Many of the new PhD faculty are using their position in the Center to transition from industry to academia or to public sector.

The Center is conscious of its lack of gender diversity, and is taking steps to remedy the situation. A Women in Data Science Conference is organized by a woman junior PhD in the Center, for example. There is also good gender balance in MS programs (60% women), but women do not stay for PhD.

As part of their outreach, the Center is helping students and older people (e.g., management) at companies to learn data science through short courses.

In short, the Center is making significant strides towards greater integration; it is proactively assessing its influence through citation and impact scores, as well as publications in strong venues; and its outreach and education activities are significant. The Center’s contributions and future directions are very good, with further improvements possible.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Centro de Investigação em Informática e Comunicações (CIIC)
Coordinator: Carlos Manuel da Silva Rabadão
Integrated PhD Researchers: 20

Overall Quality Grade: GOOD
Evaluation Criteria Ratings

(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 3
(B) Merit of the team of Integrated Researchers: 3
(C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 248 K€

Justification, Comments and Recommendations

The Politécnico de Leiria is proposing the creation of a R&D Unit entitled "Computer Science and Communication research Centre". There are 20 integrated members, all faculty members in the Politécnico. Today, polytechnic institutes in Portugal cannot grant PhD degrees, but it is expected that this will become possible in the near future. Meanwhile, the computer science faculty at the Politecnico has been able to bootstrap a PhD program so that they are currently supervising 11 PhD students. These PhD students are supported through salaries they receive as either full time or part time lecturers at Leiria. More generally, faculty members from universities in Portugal and Spain jointly supervise the research of these students who will receive their PhD degree from these universities. In addition, the students attend lectures at the universities to satisfy graduation requirements. The Panel believes that this practice of pairing with a university for purposes of supervising PhD students is an effective strategy, which shows great initiative on the part of the Center.

The faculty involved in the proposed Unit have done work in three areas: digital forensics, computer graphics and augmented reality, and sensor technology. The faculty involved in the report received 30K in 2016 to help the group improve after an earlier evaluation that ranked the group as 'Fair'. It seems they did a good job with those funds leading to a significant increase in the number of publications. That is a good message for the future. Many of the publications have been in conferences that met in the Iberian Peninsula. The Panel learned that this may be a result, at least in part, because of a lack of funding. PhD students told the Panel, for example, that they had to pay for their own travel, and so that they did not submit to international conferences regardless of the quality of the research. There are additional weaknesses in the publication record. Some publications are in a Hindawi journal, Biomed Research International which is not a selective journal. However, some Unit members have published in good journals and conferences such as Elsevier's Cognitive Computation Journal and presentations at a few international conferences such as the International Conference on Human-Computer Interaction.

These observations on publications are aligned with the advisory board comments presented in the report. The advisory board states that "an effort should be made in order to promote publishing in Scopus and ISI WoK indexed journals or conferences" and that "Overall the quality and impact of the publications is uneven. An effort should be made to concentrate in high impact journals and conferences". We endorse these recommendations. On the other hand, this Panel believes that the recommendations to encourage researchers to publish in open access journals to improve visibility is less important since high quality journals and conferences offer more than adequate visibility.

In the area of digital forensics a very successful master's degree have been created and there are now collaboration programs with national and international (Ecuador and Estonia) law enforcement agencies. Also in the area of digital forensics, participation in a contest at the 2017 "Open Source Digital Forensics Conference (OSDFCon)" led to two second places and an honorary mention. In the area of computer graphics and virtual reality systems have been developed for the Conimbriga Roman Ruins and other museums.

Two major potential difficulties the Unit faces are the large teaching load of its members, which is much higher than the load of their colleagues at universities, and the lack of extensive experience in advanced research. To attenuate their teaching load, they plan to take advantage of new regulations that will allow them to buy out time of teaching using funds from national and international projects. In any case, despite the current teaching load, and thanks to their dedication and motivation, they have been able to carry out research and contribute with publications and software modules for forensics and rendering. In the area of research expertise, Unit members are knowledgeable about the topics they plan to undertake and plan to focus on clearly important and interesting issues. However, much work remains before the Unit reaches a level of excellence. They need to continue their effort to produce research results that are of good enough quality to be accepted at top conferences and journals. Interactions with successful researchers from other institutions, for example through joint projects and colloquium series, is of crucial importance to advance the development of a successful research program.

Overall the Panel believes that the group of faculty members involved in the report can produce good research, which is demonstrated by the increment of their research production in the last two years. They can also contribute with technology transfer as shown by the relationship with companies. The faculty at the Politécnico is now struggling to get more research oriented projects. From the international point of view, they did not get any European Union funding in the past, but they are currently doing a good work in preparing proposals for H2020 calls. Nonetheless, the Panel believes that the Center has done well with the constraints under which it has been operating. The relatively new research and development thrust in cybersecurity and digital forensics appears promising and investments into a lab for that work shows foresight. Other themes of virtual and augmented reality and assistance for the elderly have produced substantial results that have to potential for a greater research presence as well.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Computação Cognitiva e Centrada nas Pessoas (COPELABS)
Coordinator: José Luis de Azevedo Quintino Rogado
Integrated PhD Researchers: 18

Overall Quality Grade: GOOD
Evaluation Criteria Ratings

(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 3
(B) Merit of the team of Integrated Researchers: 3
(C) Appropriateness of objectives, strategy, plan of activities and organization: 3

Base Funding for (2020-2023): 207 K€

Justification, Comments and Recommendations

COPELABS is a small R&D Unit whose Integrated Researchers are faculty members from the Universidade Lusófona. The Unit has overall a good record of accomplishments. They have done work mainly in the area of mobile device interconnection, peer-to-peer interaction. This work has produced a couple of prototypes such as Oi! and has been presented at good conferences such as ACM conference on Information Centric Networking (ICN) and published in recognized international magazines such as the IEEE communications Magazine. Their work has been supported by both national grants from FCT and an European H2020 grant. In addition, some members of the Unit have very good international connections. They participate in joint international projects and they have presented their work abroad at conferences and universities. In addition, the Unit and the Universidade Lusófona started a PhD program in 2012 and a few students are enrolled in this program. Overall, it is a good record of accomplishments.

The Unit's size is a handicap that limits its potential. While the record is good overall, there is a very uneven contribution from the integrated members with just a few of them carrying the burden of the research. And the size of the Unit magnifies the impact of this unevenness. They are also struggling to recruit a sufficient number of PhD students and have them persevere to graduation. Perhaps the Unit should consider creating alliances with other Units at different universities to help them address the effect of their small size.

Plans for future work includes a possible large international collaboration involving US and European industrial partners and plans to work on a wide range of topics in numerous areas including mobile and distributed computing. Although proposals, because of their nature, cannot be very specific, this one was too vague and, more importantly, too broad for such a small Unit. However, from conversations during the site visit, it was clear that some of the goals are well defined and that the Unit should be able to continue making good scientific contributions in the future.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento em Lisboa (INESC-ID)
Coordinator: Leonel Augusto Pires Seabra Sousa
Integrated PhD Researchers: 91

Overall Quality Grade: EXCELLENT
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
(B) Merit of the team of Integrated Researchers: 5
(C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 1633 K€
Recommended Programmatic Support
PhD Fellowships: 9
Programmatic Funding: 952 K€, including for 2 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations
This is an excellent application from a large and active organization which has substantial EU-level funding and whose members are internationally recognized for their research accomplishments. Team members publish in the best Computer Science conferences and serve on the program committees and steering committees of these conferences. The proposal gave several examples of successful startups based on the research outcomes of the team.

Size: INESC has 121 researchers with PhDs, organized into 5 groups. Research topics and main accomplishments of each group are described in the proposal, and the highlights are the following:
a) Embedded electronic systems: digital/analog/mixed design, parallel architectures. HIFI-MRI project for whole brain connectivity analysis using MRI brain data. Worked with Intel to integrate their cache-aware roofline model into Intel's performance analysis tools.
Startups in health and crypto.
b) Computing systems and communication networks: middleware, networks, distributed systems. Leadership in several EU-level projects (PCAS, TRACE,Euro-TM). IEEE/IFIP 2016 William Carter award for best dissertation in dependability area.
c) Information and decision support systems: biotech and precision medicine, digital humanities, enterprise systems. Start-up called HeartGenetics. 8 EU and 18 Portuguese projects including ESFRI ELIXIR Life Sciences infrastructure for biological information.
d) Interactive intelligent systems:intelligent agents, multimodal systems. Startups: VoiceInteraction, Unbabel ($23 million in Series B funding).
e) Sustainable energy systems: cross-cutting theme, power generation, power distribution, power grids, renewable energy sources like solar and wind. Led study with National Energy Services Regulatory Authority (ERSE) to determine continuity of service at endpoints on Portuguese grid. Results will be used to evaluate performance of utilities. Doubly-fed Induction Generator (DFIG-dc) design for DC networks. Control system for power convertors. Startup by former PhD student, 2 million euros of EU funding.

The Panel was impressed with the accomplishments of the INESC team.

This is a very strong group of researchers with publications in the best conferences and significant international visibility such as awards, fellowships, program committee memberships, and EU funding. Major external recognition includes the following.

There are:
Publications in top venues such as CHI, AAAI, IJCAI, ACM, WWW, ASPLOS, OSDI, VLDB, PLDI, ACL, ICSE, DAC, and ICCAD;
General co-chairs of flagship conferences of IEEE Circuits and Systems Societies (CASS);
Program committee memberships in PODC and SOSP, program co-chair of EuroSys 2016.

Program chairs for Information Retrieval conference (OAIR 2013) and other conferences in digital humanities.
ACM Distinguished Member 2017, Distinguished speaker 2015
PC chair EuroGraphics 2016.

The proposed activities mostly continue existing programs in sustainable energy, information and decision support systems, computing systems and communication networks, interactive intelligent systems, and embedded electronic systems. Cross-cutting application areas mentioned include smart health for an aging population, green energy, smart and green cities, and overall security of society. Meta-level goals include more internationalization and collaboration with industry. There was a good discussion of ethics issues in the proposal. The Panel is convinced, based on the track record of INESC, that the team will continue to do excellent work.

The Panel was impressed with the presentation in the site visit of previous accomplishments and the proposed activities.

The Panel met with the PhD students without the faculty being present. The students were happy with the research programs at INESC but they would like more integration between different research areas and research groups. They wanted more networking events where they could interact with students from other groups. Some of the international students felt that they would benefit from more institutional support in things like transfer of credits and translation of dissertations. Students were happy that they were able to visit other research groups in Europe and the US for extended research visits.

The Panel also met with the postdocs and junior faculty members. They were mostly from IST and other Portuguese institutions but they said they were becoming more international over time. They were happy with mentoring and networking opportunities.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Instituto de Engenharia Eletrónica e Informática de Aveiro - IEETA
Coordinator: Armando José Formoso Pinho
Integrated PhD Researchers: 47

Overall Quality Grade: VERY GOOD
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
(B) Merit of the team of Integrated Researchers: 4
(C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 705 K€
Recommended Programmatic Support
PhD Fellowships: 5
Programmatic Funding: 135 K€ for 1 (Junior) New PhD Researcher Contract.

Justification, Comments and Recommendations
IEETA is divided in three different sub-groups: BIT (biomedical informatics and technologies), IRIS (Intelligent Robotics and Systems) and ISP (Information Systems and Processing). A total of 47 PhD integrates IEETA.

The Panel liked the idea of focusing on a global research line oriented to solutions of Intelligent Systems for Human Assistance. The research lines of the main three groups are oriented to this global line in a very clear and smooth way. BIT contributes to advances in translational health, big data for biomedicine, telemedicine for personalized health care, etc. IRIS uses intelligent systems for assisting living, and ISP contributes novel intelligent systems for human assistance. This focus also satisfies one of the recommendations of the Advisory Board of IEETA released in July 4th, 2017 about "Focusing the strategic vision of the IEETA into a message that is more clearly distinctive, in order to support a stronger brand image".

About the research team, most of them seem to be quite active and have a strong international projection. For instance, one of the main researchers is Armando José Formoso Pinho, who has performed most of his research activity in University of Aveiro, and belongs to the Biomedical Informatics group. He is currently advising 5 postdocs, and three PhDs. One of them is concentrating on automated planning for robotics, which is a continuing collaboration that started in 2012. That research, however, has already produced interesting publications both at conferences (ICAPS) and journals (Pattern Recognition Letters and JIRS). In the last 5 years, he has advised three PhD. And 5 Masters. He is the PI of 6 projects in the last 5 years, and has participated in another 7. He has a good publication record, although regional ones are a majority for conference.

Ana María Perfeito Tomé (Biomedical Informatics Group) has also worked mainly at the University of Aveiro. In the last five years she has advised two PhD, one in collaboration with a Spanish University. She also has advised two postdocs. She has not been PI in the last years of projects, although she has participated in 3. She has an excellent record of papers in premier conferences (AAAI, NIPS, IROS) and journals (RAS, Pattern Recognition letters, etc.) in the last years, mainly in object recognition and in collaboration with her PhD. student Hamidreza Kasaei and the co-advisor Luís Seabra Lopes (Intelligent Robotics). This is an example of collaboration among both groups in IEETA.

José Luis Guimarães Oliveira (Biomedical Informatics) has worked also all the time at University of Aveiro. He has advised 6 Postdocs in the last years, and is currently advising two PhD, one of them a Marie Curie fellowship. He has advised 7 PhD in the last five years and is currently coordinating 4 European projects, with a funding level of more than 2 Million Euros, complemented with a strong number of past projects. He also has a high number of publications, both in journals and conferences.

Nuno Lau (Intelligent Robotics) has spent most of his career at University of Aveiro. He has also advised PhD students in the last years. He has coordinated and participated in the RoboCup related projects (CAMBADA and FC Portugal), which is a very interesting research line with a strong international impact. In this sense, the number of prizes obtained in the

different RoboCup competitions, for almost 20 years, is quite remarkable. The number of prizes and level of participation is comparable with the best research centers in the world. On the negative side, the high number of journal publications in the same journal (Journal of Intelligent & Robotics Systems): around 7 of the last 10 publications. Other very good journals should also be the target of the dissemination activities.

José Manuel Neto Vieira (information systems and processing) has also spent most of his career at University of Aveiro. He has also a good record of publications and projects, including European ones (H2020). Other researchers in this group, like Leonor Teixeira and Paulo Dias, also have publications in good journals (like RAS) and have participated in different projects.

As a summary, the team has strong experience in advanced training, and 70 PhD students have been (co)supervised by members of IEETA. The team has participated in many national and international evaluations panels. They also have participated in technical and editorial boards.

The capability of the Group to attract fundings is also high, and in the last years they have obtained 6M Euros in funding, only 6% of FCT. Such funding includes European H2020 projects, like EHDEN, funded with 626K Euros. Nevertheless, in the evaluation of the scientific panel they also received the suggestion of "Attempting some closer links to the region by engaging with regional entities (public bodies and industries) in exploratory projects that strengthen unique regional dimensions and, maybe, lead to novel partnerships and further social impact". Therefore, a stronger effort should be done to perform new projects and transfer technologies to local and/or international companies.

"Attracting more PhD students and postdoctoral candidates, maybe by reinforcing international branding and recruitment" was an additional suggestion provided by the advisory board. During the site visit, the committee explicitly asked the team to articulate why a PhD student or junior faculty member should come to Aveiro rather than go to another Portuguese university but the team only gave generic answers about the collegiality of the team and the low cost of living in Aveiro. The committee suggests that the team should think carefully about branding and about building networks in universities all over the world to compete with better-known universities like Porto and Coimbra for PhD students and junior faculty members.

A related weakness of the team is the high average age of the faculty members. In fact, the group recognizes that they have difficulties to recruit PhD students and researchers. A strategic plan should be established to overcome such difficulties, as to design exchange programs with other universities, and use sabbatical leaves to improve relationships with other centers that could be used for attracting new talent. In this sense, they recognize that only 20% of their students come from abroad. This is related to other of the main lacks of the research group, which is the low number of internships that PhD students, postdoctoral researchers and faculty perform. For instance, most of the PhD students recognizes that they did not plan to make any stay before leaving.

In the report, no ethical issues were defined. In the meetings the team recognized that was a mistake, and that many ethical issues must be addressed, overall, when its research target is now focused in human assistance, which may involve personal data.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: Laboratório de Inteligência Artificial e Ciência de Computadores (LIACC)
Coordinator: Luis Paulo Gonçalves Reis
Integrated PhD Researchers: 19

Overall Quality Grade: EXCELLENT
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
(B) Merit of the team of Integrated Researchers: 5
(C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 322 K€
Recommended Programmatic Support
PhD Fellowships: 4
Programmatic Funding: 412 K€, including 2 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations
LIACC is a vibrant R&D Unit involving 19 Integrated Researchers. It is organized in a straightforward management structure. The Unit convenes once per year to do brainstorming about their plans.

There are 3 major research areas: (1) DAIAS: Distributed AI & agent-based simulations (9 integrated members); (2) HMIC: human-machine interaction (5 members); (3) CS: foundational areas (5 members). By number of integrated researchers and by contributions, the most important area is DAIAS. The DAIAS projects range across a broad spectrum from the study of traffic safety to RoboCup strategies to wheelchair driving to robot dancing. There are also efforts to study scheduling applications and text mining. Many of these projects are innovative and novel.

The top three contributions listed are from the DAIAS area. The contributions of the DAIAS group include agent-based simulators and test beds for traffic, including micro level traffic simulation, using social media like Twitter to infer mobility patterns, pedestrian simulation, and gamification of some of these functions. There are several notable collaborations in this work with city and corporate entities. DAIAS has pursued practical applications that include a collaboration with the local Caetana bus company in Porto.

The second major contribution is the development of a Multi-Agent System for Disruption management. It involves a learning capability that uses both data and human interaction. They have tested a prototype in this area with TAP. A book and best Portuguese AI thesis have emerged from this work.

The first two projects have notable connections to real-world implementations that test the work with practical collaborators.

The third major area of contribution is in continuous black box optimization using evolutionary computation strategies. The work has been applied to the Portuguese RoboCup team. This work has been published widely in good venues.

All of these topics fall within the DAIAS area and make valuable research contributions to AI. The publications listed are in good venues. Although the number of citations among these projects is a bit modest, several, like those concerning transportation, also have the potential to contribute to the public good.

The fourth contribution comes from outside the DAIAS area and concerns resource scheduling and management algorithms. The fifth contribution concerns text mining and argument mining, for which they created a corpus in Portguese.

Three theoretical contributions appear to be from the CS group, although the third could be from the HMIC group. Work in programming languages has led to 5 PhDs and is the basis for a research network, which LIACC leads, on verification

of Web programming.Interesting work on job scheduling has led to very low cost, high quality schedules, that are “profit aware.”

A final promising area is in text mining and argumentation analysis. While there are established communities of AI researchers studying argument, it is understudied, and LIACC work looks promising.

The site visit confirmed the observation of the Advisory Board report that the DAIAS group is doing particularly well, that the papers and tools are of high quality, and that the technology transfer and collaboration with companies are robust. The Advisory Board did comment that there could be more connections among the groups; the new work on argumentation might provide an opportunity for this.

Future work will emphasize agent-based approaches. This builds on the Unit’s current major area of strength in DAIAS. The Unit plans to continue to use its DAIAS expertise to focus on distributed, decentralized decision-making, much of this in the context of transportation. Argument-based negotiation is to be investigated with a MAS approach. HMIC will concentrate on machine-human teams.

A notable absence in the application was the section on Ethical Issues. Ethical considerations are actually quite important to several projects, such as the work involving wheelchairs. This was addressed in the site visit: the Unit follows the EU guidelines and the university has an established an Ethics Committee.

With regard to personnel and funding, the numbers seem to be level and have not changed at all during the 2013-2107 period. There have been 30 PhD and 150 MSc theses, which is an acceptable number for a group of this size.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: LASIGE - Extreme Computing (LASIGE)
Coordinator: Vasco Thudichum Vasconcelos
Integrated PhD Researchers: 30

Overall Quality Grade: EXCELLENT
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
(B) Merit of the team of Integrated Researchers: 5
(C) Appropriateness of objectives, strategy, plan of activities and organization: 5

Base Funding for (2020-2023): 546 K€
Recommended Programmatic Support
PhD Fellowships: 4
Programmatic Funding: 495 K€, including for 2 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations
LASIGE focuses on six areas: Accessibility and Ageing, Data and Systems Intelligence, Health and Biomedical Informatics Cyber-Physical Systems, Resilient Distributed and Networked Systems, Reliable Software Systems

The researchers have identified five key contributions: Accessibility, Applied Formal Methods, Cloud, Complex Data, Securing Critical Infrastructures.
In each of those contributions the work is very impressive, at top international standards. The research topics are all of great interest. In the report they mention: accessibility, applied formal methods, Cloud storage and fault tolerance, complex data analysis, and security. The Unit is also doing very well in a number of areas including: technology transfer, publications, software distribution, and participation in the organization of international conferences.

The researchers are prominent and very active on the international scene and in the EU (FP7, H2020 etc.). They are publishing in top venues and receiving due recognition. Several members of the Unit have excellent resumes in terms of their involvement in community efforts, awards, and publication in top conferences. The Advisory Board report of February, 2018 concurs with this evaluation. They are professionally engaged scholars with international engagement, visibility and success.

The researchers are focused on topics of great social importance including accessibility, reliability, technology for aging well and some of the UN's Sustainable Development goals. The work is made available on line with benchmarks and prototypes for public dissemination. There is a clear sense of social responsibility in the work. The researchers are of high calibre producing top quality work. They are tackling timely and central questions in computing. They appear to work well together as a team.

This is a large, active organization with lots of projects, many international, and students, both doctoral and MSc. It has an excellent record of participating in important efforts such as the EU's Web Accessibility effort and writing ethics guidelines. There have been two spinoffs and 27 tech transfer efforts. A significant number of new researchers are to be hired in 8 areas. Noteworthy is the proposal to hire a cognitive psychologist and a biomedical researcher in the effort on accessibility and aging, There is a lot envisioned support for young PhD and doctoral students.

The plan is excellent. The research is organized along several well defined lines. They have a strong ongoing participation in EU proposals. They have plans to mentor young researchers and strategy to stimulate excellence in research.

LASIGE plans to expand its activity to include new areas of research, all of which represent extensions of LASIGE's main core areas of activity, namely Accessibility & Ageing, Cyber-physical Systems, Data & Systems Intelligence, Health & Biomedical Informatics, Reliable Software Systems, and Resilient Distributed & Networked Systems.

LASIGE plans to create new areas of excellence in four concrete domains i) Protocols to support blockchain systems and applications; ii) Resilient operation and management of highly dynamic programmable networks; iii) Computational optimization of user interfaces based on real world usage; iv) High performance automated reasoners to tackle computational problems beyond current reach. Each of these is an appropriate target.

There is a continued emphasis on applications of high social relevance. LASIGE plans to create a spin-off to be actively involved in the upcoming digital accessibility regulation of public bodies. The technology produced and the resulting company could influence the quality of public digital services for people with special needs. LASIGE is also responsible for the creation of the University Living Lab in the area of health & wellbeing tourism for older adults, a lab instrumental for the deployment of research and industrial projects with a significant impact on a current challenge of the European and Portuguese society. Three other immediate objectives, derived from existing protocols and spin-offs, are: i) the development of technology to assist the homeless population and supporting institutions, ii) the dissemination and refinement of technology to drastically decrease the waste of water in irrigation systems, iii) evolving LASIGE health-related technology for tetraplegic young adults and persons with ALS, Dementia, and Parkinson. These projects will all require extensions of the technology and careful attention to human needs and habits. The payoffs could be substantial.

The LASIGE is evolving its organizational structure in appropriate ways to focus on interdisciplinary research in a most self-aware and self-critical way. The researchers are clearly aware of the need for ethical practices and plan to put them in a central role. In particular the researchers are keen to make issues of equity central and to help underserved populations.

The budget reflects the need to expand the number of research personnel and to provide good administrative support. The budget justification is well-thought out and appropriate.

Evaluation Panel: ENGINEERING SCIENCES AND TECHNOLOGIES - Computer Science and Information Technologies

R&D Unit: NOVA Laboratory for Computer Science and Informatics (NOVA LINCS)
Coordinator: Luís Manuel Marques da Costa Caires
Integrated PhD Researchers: 57

Overall Quality Grade: EXCELLENT
Evaluation Criteria Ratings
(A) Quality, merit, relevance and internationalization of the R&D activities of the Integrated Researchers in the R&D Unit Application: 5
(B) Merit of the team of Integrated Researchers: 5
(C) Appropriateness of objectives, strategy, plan of activities and organization: 4

Base Funding for (2020-2023): 992 K€
Recommended Programmatic Support
PhD Fellowships: 7
Programmatic Funding: 697 K€, including for 2 (Junior) New PhD Researchers Contracts.

Justification, Comments and Recommendations
NOVA Laboratory for Computer Science and Informatics (LINCS) is an R&D Unit led by Luís Caires in the Departamento de Informática at Universidade Nova de Lisboa. Its 57 PhD researchers and 45 PhD students are largely at Universidade Nova de Lisboa, but also at Universidade de Évora, Universidade da Beira Interior, and Universidade da Madeira. LINCS is organized into four groups: Computer Systems, Knowledge-Based Systems, Multimodal Systems, and Software Systems. The committee's visit included an overview presentation of the Unit, meetings with PhD students, junior PhD researchers, and senior PhD researchers, with much of the time devoted to questions and discussion.

NOVA LINCS has continued its established excellence in information and computing technology. Examples of where they have made significant contributions include emotionally intelligent multi-modal interfaces, representation of debates in social networks, cloud computing informed by geo-distribution, automated reasoning systems that can explain their reasoning, and computing in cultural heritage and the arts.

Researchers in all four groups publish in prominent international venues for their respective areas. They have an excellent record of PhD graduate production. The Unit's leadership has established structures and programs that have created a positive, supportive environment for collaborative efforts. They have effective institutional support for their efforts. They have productive collaborations with Carnegie Mellon University and Carnegie Mellon that are being successfully exploited by faculty and students. They have good connections with the EU, global industry, and the local community.

The Unit's integrated faculty are publishing in top journals and, most importantly, conference venues, including multiple best paper awards. There is healthy collaboration both with members of the Unit and outside it. They are creating PhD students who are well-read and interesting to talk to. The Unit researchers are engaged in various leadership roles in their profession, including editorial board memberships and chairing key conferences.

The Unit proposes the following themes to pursue:
- Computing for Healthcare
- Big Data and Artificial Intelligence
- Computing for Sustainability
- Computing for Cultural and Arts
- Concurrent & Distributed Software
- Trustworthy Live Software Development
- Model-driven Engineering for Cyber-Physical Systems

These are timely and successfully bring together researchers in various subsets of the research groups.

As is common in Portuguese academic and research institutions, many of the integrated faculty in LINCS come from the Unit itself. This can be problematic when it leads to lack of diversity in research areas. For example, the Knowledge

Based Systems area of LINCS has excellence in knowledge representation and automated reasoning but has gaps in areas that a well-rounded group in artificial intelligence would typically span. Some of these areas are being explored elsewhere within LINCS, particularly in Multimodal Systems, and it would strengthen LINCS to more tightly tie together their strengths in AI. Further, while there is value in building on areas of great strength, there are areas such as AI where LINCS is sufficiently strong that they should consider what areas are not currently well represented in the Unit and seek to grow in those directions.

The committee was also struck by the small number of women involved in the Unit. For example, the meeting with younger PhD researchers did not have a single woman. Although the Panel is confident that the members of LINCS would like greater diversity, in practice such trends are not reversed without explicit programmatic efforts to do so. The Panel encourage LINCS to explore what practices other institutions have followed to increase diversity and establish programs to accomplish this at their Unit.