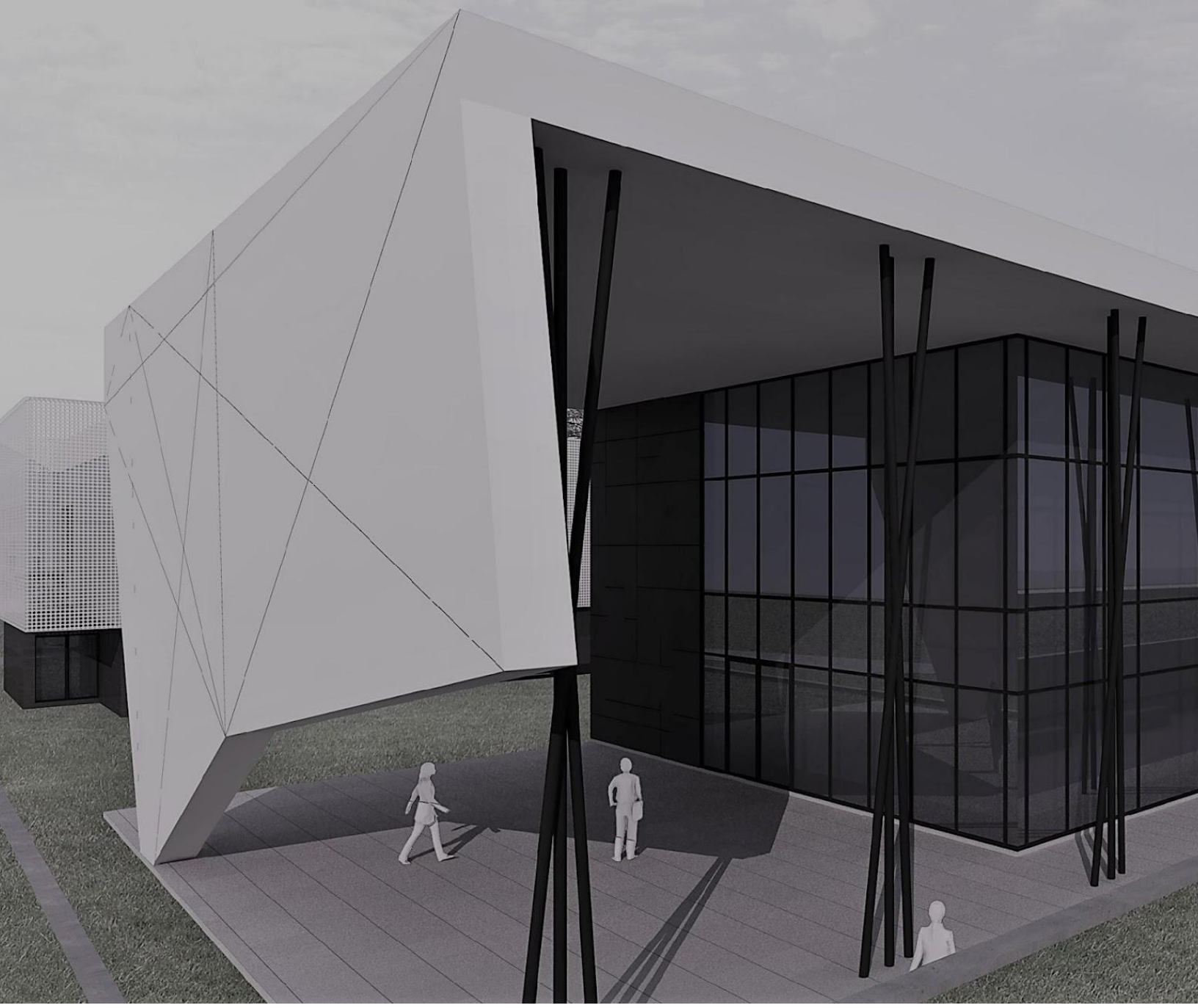

Annual Report 2021

APPLIED
ARTIFICIAL
INTELLIGENCE
LABORATORY

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1. INTRODUCTION

The R&D Unit Applied Artificial Intelligence Laboratory (2Ai) was created in the Polytechnic Institute of Cávado and Ave (IPCA) in 2018. In January 2020, 2Ai received the Very Good classification by FCT (on a scale of Not recognized, Weak, Good, Very Good and Excellent). It pursues applied research advances on artificial intelligence (AI), namely in intelligent systems, human-AI Collaboration and robotics for health, industry, environment and security. This cross-cutting themes and multidisciplinary interface fosters the generation of value through the development of innovative products and smart services, resulting from internationally highly competitive research.

2Ai is a fully incorporated research structure within the School of Technology (EST) of IPCA. 2Ai is a research unit within the young and innovative EST, guided by values of excellence and proximity at the regional level. The research center is composed of a young group of 15 integrated members with Ph.D., and most of their members have received a Ph.D. degree in the last 10 years.

2. OBJECTIVES AND AIMS

The 2Ai scientific vision focuses on augmenting the knowledge, information and interaction at the disposal of agents, robots and humans to improve their performance at the target areas. To this end, we aim to apply machine learning techniques, spanning natural language processing, deep-learning and computer vision, to extract information and provide knowledge to potentiate intelligent decision automation systems and human-AI collaboration. 2Ai will also strongly focus on the application of gamification concepts as an engine for the development of new smart and personalized training approaches. Furthermore, the search for more natural interfaces to improve the overall control of the context environment will complete an integrated suite of research efforts, on the path towards innovative technologies and smarter services.

The creation of this type of solutions can generate new markets, and improve efficiency of existing goods and services across the 2Ai impact areas:

- **Healthcare:** The development of novel AI services aiming to provide innovative decision support systems for improved medical diagnoses. It also has potential to improve

telemedicine, assist in repetitive medical tasks and enhance smart surgical rooms with robots, natural user interfaces, and augmented reality setups by combining different image sources. Additionally, smart data analysis strategies will be pursued as a key factor in order to better correlate illness evolution to their treatment. In the long-term, the goal is to provide more efficient pipelines to promote proactive and personalized clinical services.

- **Industry:** AI services to increase production capabilities through more reliable forecast of market demand, increased flexibility in operations and the supply chain and equipment failure prediction will drive this research area. By applying these solutions, smarter, faster, cheaper production approaches are expected. Furthermore, the application of game-based learning tools, with virtual and augmented reality, collaborative robots and smart virtual assistants are expected to improve productivity and the employees' health and safety.

- **Environment and security:** AI services, combining aerial robots and artificial vision, to perform a smart monitoring of natural environments (e.g., forests) will be pursued. These AI services can gather site-specific and timely data about different dynamic aspects of the environment, generate warnings only when and where they are needed, and create a historical record of the environment. AI can also assist in the supervision and detection of anomalous conditions, providing situational awareness for a broad range of monitoring services. Distributed sensor systems complemented with AI can further increase pattern understanding of normal conditions, and detect when the probability of change rises significantly, whether triggered by natural or human causes.

In order to fulfill these aims, 2Ai defined a research plan focused on the following main strategies:

a) - Research and development of novel and effective methods for innovative services applied to the 2Ai impact areas (S1);

b) - Development of shared public databases and prototyping tools for AI training, testing and validation (S2) ;

c) - Study the regional and national landscape to foster a sustainable and healthy AI R&D ecosystem, combining academia, industry and experts (S3);

d) - Prototype systems as proof-of-concepts leading to the creation of intelligent services and applications, enhance the translation of new tools and promote innovation through the creation and nurturing of new SMEs and spin-offs (S4);

e) - Contribute to the creation of a critical mass of highly skilled human resources in AI by attracting and collaborating with leading researchers, entrepreneurs, and experts active in the field (S5);

f) - Attraction of funds and investors for research (S6).

2.1. MAIN ACHIEVEMENTS DURING THE YEAR OF 2021

According to the defined strategic plan, the following achievements were obtained in 2021.

Strategic Aim	Outcomes
S1	While the first years of the 2Ai unit were focused on the construction of the R&D working basis, funding collection and team construction, our goals to 2021 are centered on the scientific component through top research and good scientific practices. In 2021, a total of 18 journal publications (16 in peer-review journals (ISI/Scopus indexed)), 45 proceedings in international conferences, 7 proceedings in national conferences, 3 book chapters and 5 patents were submitted. This represents an average of 3.5 publications per integrated researcher (15 integrated members). From the published works (ISI/Scopus indexed peer-review journals), 94% of the studies were included in top-rank journals (Q1 and Q2). Particularly, 44% Q1 and 50% Q2 journals publications were obtained. In comparison to 2020, while it was registered a similar number of journal publications, an increase of 160% was registered for the total number of conference proceedings. Moreover, a

	notable increase in the number of applications for patents (1 patent in 2020) was registered. Most of the peer-review journals were published in collaboration with other European R&D centers, such as: Physics Center of University of Minho (Portugal), Algoritmi Research Center of University of Minho, (Portugal), LIACC of Faculty of Engineering of the University of Porto (Portugal), Department for Neonatology and Pediatric Intensive Care Medicine of University Hospital Carl Gustav Carus (Dresden, Germany), Universitätsklinikum Bonn (Bonn, Germany), The Chinese University of Hong Kong (Hong Kong, China), and Lab on Cardiovascular Imaging and Dynamics, KU Leuven (Belgium), demonstrating the good research network of 2Ai members. Moreover, a policy of fostering an active involvement of students within the 2Ai research projects was pursued, through 31 completed bachelor projects, 90 master students (15 completed and 75 ongoing) and 19 PhD students (2 completed and 17 ongoing).
S2	Focused on the development of AI methodologies, 13 public databases, 7 mathematical models, 16 computational applications, 11 laboratory prototypes and 1 pilot installation were released in 2021. To promote good scientific practices, through open sciences politics, most of the databases are publicly released.
S3	The first Portuguese Associated Laboratory totally dedicated to Intelligent Systems (i.e. LASI - Intelligent Systems Associated Laboratory) was accepted and recommended for funding by the Portuguese Foundation for Science and Technology. 2Ai was integrated as one of the founder's members. In 2021, 2Ai actively participated in the definition of the scientific and management guidelines. Overall, the LASI aims to promote scientific employment in Portugal, to create straight collaboration between industries and research and to enhance the international dissemination of

	all R&D members. Moreover, it aims to promote the internalization of all R&D entities and promote technology transfer politics, through dedicated offices and constant participation in international events (e.g. industrial fairs). Internationally, 2Ai members organized a total of 9 international conferences/symposiums targeting 2Ai related impact areas. At a regional level, and within the scope of the partnership established between 2Ai and other two R&D units, CeDRI of Polytechnic Institute of Bragança and ADiT-LAB of Polytechnic Institute of Viana do Castelo, a set of webinars entitled "Talk For Us" Webinars were organized. Concerning the webinars, the invited speakers were researchers and professors from each R&D Unit (2Ai, CeDRI and ADiT-LAB). The main objective of these webinars focuses on sharing scientific and technological knowledge and promoted the possibility of researchers to show their work and research projects. These sessions were bimonthly and took place in an online format (videoconference - Zoom). The "Talk For Us" Webinars will continue to take place in 2022. Additionally, to promote the research collaboration between the three abovementioned Polytechnic Institutes, a common conference entitled Symposium of Applied Science for Young Researchers (SASYR) was organized. SASYR aimed to provide a friendly and relaxed environment for young researchers to present their work, to discuss recent results and to develop new ideas. These webinars and joint symposiums were oriented toward both the scientific and industrial communities. 2Ai also organized open sessions entitled "2Ai Talks", which were based on a set of internal scientific presentations performed by 2Ai integrated members and researchers followed by scientific and technological discussion. The 2Ai Talks were oriented toward both scientific and industrial communities. These sessions allowed the researchers and integrated members to present a topic or their research work. The 2Ai Talks Sessions promoted scientific and technological discussions among 2Ai

	researchers. The 2Ai Talks sessions were bimonthly and took place in a presential format. These sessions will continue to take place in the next year 2022. 2Ai promoted the weekly sessions titled "2Ai Journal Club", where each researcher presented a recent publication from a scientific journal in their expertise area to share the scientific/technological content and innovation of this publication. These publications can be from the 2Ai researchers or belong to another research group. These sessions were composed of oral presentations and scientific and technological discussions. 2Ai will continue to promote these sessions in 2022. Finally, 2Ai also established strategic partnership protocols with neighborhood secondary schools (Escola Secundária Henrique Medina and Agrupamento de Escolas Rosa Ramalho) aiming to approximate the secondary schools' students of 2Ai and IPCA activities. In this context, 2Ai enrolled in the FCT Program entitled "Programa Cientificamente Provável", targeting the promotion of knowledge and the enrichment of the training path of young people, through the establishment of closer links between higher education institutions and primary and secondary schools, with the intermediation of school libraries.
S4	2Ai reinforced the total number of co-promotion projects in collaboration with industries (with 3 new projects accepted and 2 further projects under analysis). 2Ai members also targeted the protection of intellectual property through 5 patents (increasing the total number in comparison to 2020, where only one patent was registered).
S5	2Ai offered a set of advanced courses for training in emergent technological areas, namely Fundamentals of VFX in Foundry Nuke, Introduction to Machine Learning, Natural Language Processing, Data Analysis and

	Affective Computing. In the context of the COVID-19 pandemic and the contingency plan and measures decreed by the Portuguese Government, it was possible to take the Data Analysis advanced course in presential mode, respecting health safety rules. The advanced course "Data Analysis" took place in the week between 12 and 16 July, 2021, and was attended by participants from 4 European countries (Poland, Bulgaria, France and Portugal). The Advanced Courses Coordination decided to create two new offers of Advanced Courses for the 2022 Edition in the Applied Cybersecurity and Deep Learning for Computer Vision areas, as well as the possibility that some advanced courses will take place online mode if the pandemic context worsens. A dedicated master of applied artificial intelligence (M2Ai) was accredited and started its first edition in 2021. Moreover, 2Ai fosters collaborations between its researchers and international partners focused on 2Ai impact areas, specifically a total of 2 research collaborations were established. 2Ai is also enrolled in the definition of institutional research careers guidelines. Under the RUN-EU+ project (recommended for funding by the H2020), 2Ai is involved in a large European consortium and it is currently performing an exhaustive gap analysis of the current scientific practice and it will focus on the implementation of the future guidelines for scientific practice and research careers.
S6	A total of 15 projects were submitted in 2021 targeting national, industrial cooperation and European calls. Only in 2021, a total amount of 1.593.525,04€ was collected in 5 accepted projects. This value corresponds to an average of ~100k€ raised per integrated member. Moreover, a European project, directly funded by the H2020 program, was

	recommended for funding. Overall, 2Ai currently has 19 projects ongoing with total funding of >4.5M€ (2020-2023).

A summary of the scientific outcomes obtained by the 2Ai members is presented in Table 1. The outcomes are presented according to the standard guidelines of the Portuguese Foundation for Science and Technology (FCT).

Table 1 - Summary of the 2Ai' scientific outcomes

Scholarship	Nº of Positions
A. Publications	
A1. Books / Book Chapters	0/3
A2. Scientific Publications in International Journals	18
A3. Scientific Publications in National Journals	0
B. Conferences	
B1. Proceedings in International Conferences	45
B2. Proceedings in National Conferences	7
C. Reports	1
D. Organization of conferences	9
E. Advanced Training	
E1. PhD Thesis	2
E2. Master Thesis	15
F. Mathematical Models	7
G. Computational applications	16
H. Pilot Installations	1
I. Laboratorial Prototypes	11
J. Patents / Provisional Patents	5

3. PRODUCTIVITY

3.1. PUBLICATIONS IN PEER-REVIEW JOURNALS

1. Mendes-Felipe, C. , Barbosa, J.C., Gonçalves, R., Miranda, D., Costa, C.M., Vilas-Vilela, J.L., Lanceros-Mendez, S. (2021). Lithium bis(trifluoromethanesulfonyl)imide blended in polyurethane acrylate photocurable solid polymer electrolytes for lithium-ion batteries. *Journal of Energy Chemistry.*DOI: https://doi.org/10.1016/j.jechem.2021.01.030 *(ISI indexed journal: IF: 9.676; Q:Q1; Scopus indexed journal; Scimago (SJR): Q:Q1)*
2. Borges, J., Queirós, S., Oliveira, B., Torres, H., Rodrigues, N., Coelho, V., Pallauf, J., Brito, J. H., Mendes, J. and Fonseca, J.C. (2021).A system for the generation of in-car human body pose datasets. *Machine Vision and Applications*. DOI: https://doi.org/10.1007/s00138-020-01131-z *(ISI indexed journal: IF: 2.012; Q:Q2; Scopus indexed journal; Scimago (SJR): Q:Q2)*
3. Gonçalves, R., Miranda, D., Marques-Almeida, T., Silva, M.M., Cardoso, V.F., Almeida, A.M., Costa, C.M., Lanceros-Méndez, S. (2021). Patterned separator membranes with pillar surface microstructures for improved battery performance. *Journal of Colloid and Interface*. DOI: https://doi.org/10.1016/j.jcis.2021.03.138 *(ISI indexed journal: IF: 8.128; Q:Q1; Scopus indexed journal; Scimago (SJR): Q:Q1)*
4. Fernandes, A.C., Vilhena, E., Oliveira, R., Sampaio, P. and Carvalho, M.S. (2021). Supply chain quality management impact on organization performance: results from an international survey. *International Journal of Quality & Reliability Management*. DOI: https://doi.org/10.1108/IJQRM-05-2020-0159 *(Not ISI indexed journal: IF: NA; Q:Q2; Scopus indexed journal; Scimago (SJR): Q:Q2)*
5. Putnik, G. D., Shah, V., Putnik, Z. and Ferreira, L. (2021). Machine Learning in Cyber-Physical Systems and Manufacturing Singularity – It Does Not Mean Total Automation, Human is Still in the Centre: Part II – In-CPS and a View from Community on Industry 4.0 Impact on Society. *Journal of Machine Engineering*. DOI: https://doi.org/10.36897/jme/134245 *(Not ISI indexed journal: IF: NA; Q:Q2; Scopus indexed journal; Scimago (SJR): Q:Q2)*

6. Hiraoka, A., Symons, R., Bogaert, J.A., Morais, P., Van De Bruaene, A., Budts, W., Bogaert, J. (2021). Assessment of long-term cardiac adaptation in adult patients with type II atrial septal defect : A cardiovascular magnetic resonance (CMR) study. *European Radiology*. DOI: https://doi.org/10.1007/s00330-020-07364-w *(ISI indexed journal: IF: 5.315; Q:Q1; Scopus indexed journal; Scimago (SJR): Q:Q1)*
7. Nelles, D., Lambers, M., Schafigh, M., Morais, P., Schueler, R., Vij, V., Tiyerili, V., Weber, M., Schrickel, J.W., Nickenig, G., Hammerstingl, C., Sedaghat, A. (2021). Clinical outcomes and thrombus resolution in patients with solid left atrial appendage thrombi: results of a single-center real-world registry. *Clinical Research in Cardiology*. DOI: https://doi.org/10.1007/s00392-020-01651-8 *(ISI indexed journal: IF: 5.460; Q:Q1; Scopus indexed journal; Scimago (SJR): Q:Q1)*
8. Morais, P., Fan, Y., Queirós, S., D'hooge, J., Lee, A. PW. and Vilaça, J. L. (2021). Feasibility and Accuracy of Automated Three-Dimensional Echocardiographic Analysis of Left Atrial Appendage for Transcatheter Closure. *Journal of the American Society of Echocardiography*. DOI: https://doi.org/10.1016/j.echo.2021.08.023. *(ISI indexed journal: IF: 5.251; Q:Q1; Scopus indexed journal; Scimago (SJR): Q:Q1)*
9. Santos, D., Simões, A. and Mota, C. (2021). Broad coverage emotion annotation. *Lang Resources & Evaluation*. DOI: https://doi.org/10.1007/s10579-021-09565-1 *(ISI indexed journal: IF: 1.358; Q:Q1; Scopus indexed journal; Scimago (SJR): Q:Q1)*
10. Pedras, S. Santos, D., Vilhena, E., Carvalho, R. and Pereira, M.G. (2021). Tradução, adaptação e validação das escalas de experiência de amputação (TAPES-R). *PSICOLOGIA, SAÚDE & DOENÇAS*. DOI: http://dx.doi.org/10.15309/21psd220213 *(Not ISI indexed journal: IF: NA; Q:NA; Not Scopus indexed journal; Scimago (SJR): Q:NA)*
11. Costa, M.S.A., Vilhena, E., Leite, A., Almeida, A.C., and Pereira, M.G. (2021). Quality of Life in Caregivers of Type 2 Diabetes Patients After Patient's Surgery: a Path Analysis. *International Journal of Behavioral Medicine.* DOI: https://doi.org/10.1007/s12529-021-10028-8 *(ISI indexed journal: IF: 2.229; Q:Q2; Scopus indexed journal; Scimago (SJR): Q:Q2)*

12. da Costa, N.M.C., Bicho, E., Ferreira, F., Vilhena, E. and Dias, N.S. (2021). A Multivariate Randomized Controlled Experiment about the Effects of Mindfulness Priming on EEG Neurofeedback Self-Regulation Serious Games. *Applied Sciences*. DOI: https://doi.org/10.3390/app11167725 *(ISI indexed journal: IF: 2.679; Q:Q2; Scopus indexed journal; Scimago (SJR): Q:Q2)*
13. Eusébio, J. and Carvalho, V. (2021). Virtual Interface with Kinect 3D Sensor for Interaction with Bedridden People. *International Journal of Healthcare Information Systems and Informatics (IJHISI)*. (Accepted for publication, 2021). *(Not ISI indexed journal: IF: NA; Q:Q3; Scopus indexed journal; Scimago (SJR): Q:Q3)*
14. Coimbra, N., Ribeiro, A. and Vilhena, E. (2021). DETERMINANTES DA RENTABILIDADE DOS CAPITAIS PRÓPRIOS: O CASO DAS EMPRESAS NÃO FINANCEIRAS EM PORTUGAL. *GESTIN– Revista Científica da Escola Superior de Gestão de Idanha-a-Nova*. URL: https://gestin.ipcb.pt/index.php/gestin-xxii *(Not ISI indexed journal: IF: NA; Q:NA; Not Scopus indexed journal; Scimago (SJR): Q:NA)*
15. Rodrigues-Marinho, T., Pereira, P., Correia, V., Miranda, D., Lanceros-Méndez, S. and Costa P. (2021). Transparent Piezoelectric Polymer-Based Materials for Energy Harvesting and Multitouch Detection Devices. *ACS Applied Electronic Materials*. DOI: https://doi.org/10.1021/acsaelm.1c01004 *(ISI indexed journal: IF: 3.314; Q:Q1; Scopus indexed journal; Scimago (SJR): Q:Q1)*
16. Melo, C., Dixe, S., Fonseca, J.C., Moreira, A.H.J. and Borges, J. (2021). AI Based Monitoring of Different Risk Levels in COVID-19 Context. *Sensors 2022*. DOI: https://doi.org/10.3390/s22010298 *(ISI indexed journal: IF: 3.576; Q:Q2; Scopus indexed journal; Scimago (SJR): Q:Q2)*
17. Mateus-Coelho, N., Cruz-Cunha, M. and Silva-Ávila, P. (2021). Application of the Industry 4.0 technologies to mobile learning and health education apps. *FME Transactions*. DOI: http://dx.doi.org/10.5937/fme2104876m *(Not ISI indexed journal: IF: NA; Q:NA; Scopus indexed journal; Scimago (SJR): Q:Q2)*
18. Ávila, P., Pires, A., Putnik, G., Bastos, J. and Cruz-Cunha, M. (2021). Value analysis as a mechanism to reduce the complexity of the selection of the resources system for Agile/Virtual Enterprises in the context of Industry 4.0. *FME Transactions.* DOI:

http://dx.doi.org/10.5937/fme2104806A *(Not ISI indexed journal: IF: NA; Q:NA; Scopus indexed journal; Scimago (SJR): Q:Q2)*

3.2. PUBLICATIONS IN INTERNATIONAL CONFERENCES

1. Dominguez, M. J., Outeriño, D.B., and Simões, A. (2021). Automatic lexicographic content creation: Automating multilingual resources development for lexicographers. In *Post Editing Lexicography. Proceedings of the eLex 2021 conference*, page forthcoming. *In Press.*
2. Simões, A. and Queirós, R. (2021) Experiments on PR-based gamification. In Pedro Rangel Henriques, Filipe Portela, Ricardo Queirós, and Alberto Simões, editors, *2nd International Computer Programming Education Conference (ICPEC)*. *In Press. (ISI/Scopus indexed International Conference Paper)*
3. Simões, A., Salgado, A. and Costa, R. (2021). LeXmart: A platform designed with lexicographical data in mind. In *Post Editing Lexicography. Proceedings of the eLex 2021 conference*, page forthcoming. *In Press.*
4. Carvalho, N.R, Almeida, J.J. and Simões A. (2021). Bootstrapping a data-set and model for question-answering in Portuguese. In *10thSymposium on Languages, Applications and Technologies (SLATE)*. *(ISI/Scopus indexed International Conference Paper)*
5. Simões, A. and Gamallo, P. (2021). LeMe–PT: a medical package leaflet corpus for Portuguese. In *10thSymposium on Languages, Applications and Technologies (SLATE)*. *(ISI/Scopus indexed International Conference Paper)*
6. Vieira, A. R., Dias I. and Simões, A. (2021). Encoding and publishing idiom dictionaries using XML technologies. In *ASIALex 2021, 14thInternational Conference of the Asian Association for Lexicography*.
7. Oliveira, I., Barros, M., Simões, A. and Duque, D. (2021). Agent-based terrain generation: comparing sequential vs concurrent approaches. In *International Conference on Graphics and Interaction (ICGI)*.

8. Oliveira, V. M., Morais, P., Oliveira, O., Vilaça, J. L. and Moreira, A. H. J. (2021). Exploring current communication frameworks for medical teleoperation. In *IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/1109/SEGAH52098.2021.9551888 *(ISI/Scopus indexed International Conference Paper)*
9. Torres, H.R, Oliveira, B., Morais, P., Fritz, A., Veloso, F., Rüdiqer, M., Fonseca, J.C. and Vilaça, J.L. (2021). Developing a medical training game for visual assessment of head deformities in infants. In *IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/1109/SEGAH52098.2021.9551906 *(ISI/Scopus indexed International Conference Paper)*
10. Valente, S., Real, A., Gomes-Fonseca, J., Torres, H.R., Lima, E., Morais, P. and Vilaça, J. L. (2021). A new handheld ultrasound probe simulator for medical training. In *IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/10.1109/SEGAH52098.2021.9551859 *(ISI/Scopus indexed International Conference Paper)*
11. Mendes, A., Duque, D. and Carvalho, V. (2021). Virtual Reality on Therapy and Diagnosis of Schizophrenia: First Insights. In *International Conference on Graphics and Interaction (ICGI 2021)*. *(ISI/Scopus indexed International Conference Paper)*
12. Silva, R., Duque, D., Melo, M. and Moura, J. M. (2021). The Benefits of Virtual Reality Technology for Rehabilitation of Children with Autism: A Systematic Review. *In International Conference on Graphics and Interaction (ICGI)*. DOI: https://doi.org/10.1109/ICGI54032.2021.9655278 *(ISI/Scopus indexed International Conference Paper)*
13. Pereira, D., Duque, D. and Carvalho, V. (2021). A Systematic Review of the Use of Virtual Reality Games in Post-stroke Rehabilitation. In In *IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/10.1109/SEGAH52098.2021.9551901 *(ISI/Scopus indexed International Conference Paper)*
14. Molho, C., Vilhena, E. and Sousa, B. (2021). The role of digital marketing communication in brand equity : A study applied to Altice Forum Braga. *In 16th*

Iberian Conference on Information Systems and Technologies (CISTI). DOI: https://doi.org/10.23919/CISTI52073.2021.9476636 *(ISI/Scopus indexed International Conference Paper)*

15. Putnik, G.D., Putnik, Z., Shah, V., Varela, L., Ferreira, L., Castro, H., Catia, A. and Pinheiro, P. (2021). Collaborative Engineering definition: Distinguishing it from Concurrent Engineering through the complexity and semiotics lenses. In *IOP Conference Series: Materials Science and Engineering*. DOI: https://doi.org/10.1088/1757-899x/1174/1/012027 *(ISI/Scopus indexed International Conference Paper)*
16. Putnik, G.D., Putnik, Z., Shah, V., Varela, L., Ferreira, L., Castro, H., Catia, A. and Pinheiro, P. (2021). Collaborative Engineering: A Review of Organisational Forms for Implementation and Operation. In *IOP Conference Series: Materials Science and Engineering*. DOI: https://doi.org/10.1088/1757-899x/1174/1/012028 *(ISI/Scopus indexed International Conference Paper)*
17. Lima, B., Ferreira, L. and Moura, J. M. (2021). Helping to detect legal swimming pools with Deep Learning and Data Visualization. *Procedia Computer Science*. DOI: https://doi.org/10.1016/j.procs.2021.01.301 *(ISI/Scopus indexed International Conference Paper)*
18. Gonçalves, D., Ferreira, L. and Campos, N. (2021). Enterprise architecture for high flexible and agile company in automotive industry. *Procedia Computer Science*. DOI: https://doi.org/10.1016/j.procs.2021.01.303 *(ISI/Scopus indexed International Conference Paper)*
19. Mateus-Coelho, N., Cruz-Cunha and M., Ferreira, L. (2021). Security in Microservices Architecture. *Procedia Computer Science*. DOI: https://doi.org/10.1016/j.procs.2021.01.320 *(ISI/Scopus indexed International Conference Paper)*
20. Alves, F., Mateus-Coelho, N. and Cruz-Cunha, M. (2021). Encryption File System Framework – Proof of Concept. *Procedia Computer Science*. DOI: https://doi.org/10.1016/j.procs.2021.01.322 *(ISI/Scopus indexed International Conference Paper)*

21. Ávila, P., Mota, A., Bastos, J., Patrício, L., Pires, A., Castro, H., Cruz-Cunha, M.M. and Varela, L. (2021). Framework for a risk assessment model to apply in Virtual / Collaborative Enterprises. *Procedia Computer Science*. DOI: https://doi.org/10.1016/j.procs.2021.01.208 *(ISI/Scopus indexed International Conference Paper)*
22. Rocha, A., Romero, F., Cunha, M., Lima, R. and Amorim, M. (2021). A Preliminary Analysis of the Use of Valuation Methods by Technology Transfer Offices. In *Proceedings of the 18th International Conference on e-Business – ICE-B*. DOI: https://doi.org/10.5220/0010599901360143 *(ISI/Scopus indexed International Conference Paper)*
23. Correia, H. A. and Brito, J. H. (2021). Violence detection in video game metadata using ConvLSTM. In In *IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/10.1109/SEGAH52098.2021.9551853 *(ISI/Scopus indexed International Conference Paper)*
24. da Costa, N. M. C., Bicho, E. G. and Dias, N. S. (2021). NeuroPrime: a Pythonic framework for the priming of brain states in self-regulation protocols. In *IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/10.1109/SEGAH52098.2021.9551893 *(ISI/Scopus indexed International Conference Paper)*
25. Martins, P. M., Vilaça, J. L. and Dias, N. S. (2021). A study about current digital assistants for healthcare and medical treatment monitoring. *In IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/10.1109/SEGAH52098.2021.9551864 *(ISI/Scopus indexed International Conference Paper)*
26. Pinto, J. F., Vilaça, J. L. and Dias, N. S. (2021). A Review of Current Pill Organizers and Dispensers. In *IEEE 9th International Conference on Serious Games and Applications for Health (SeGAH 2021)*. DOI: https://doi.org/10.1109/SEGAH52098.2021.9551894 *(ISI/Scopus indexed International Conference Paper)*

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3.3. PUBLICATIONS IN NATIONAL CONFERENCES

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2. Valente, S., Real, A., Gomes Fonseca, J., Torres, H. R., Lima, E., Morais, P. and Vilaça, J.L. (2021). A New Concept of a Handheld Ultrasound Guidance for Medical Training. In *Symposium of Applied Science for Young Researchers (SASYR 2021)*. URL: http://sasyr.ipb.pt/files/SASYR_Book_Abstracts.pdf#page=42
3. Araújo, T., Pereira, M. and Vilhena, E. (2021). Robotized Automation Systems For Industry Supported By Integrated Quality And Environment System Management Solutions. In *Symposium of Applied Science for Young Researchers (SASYR 2021)*. URL: http://sasyr.ipb.pt/files/SASYR_Book_Abstracts.pdf
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3.4. BOOK CHAPTERS

1. Cerqueira, J. M., Cleto, B., Moura, J. M., Sylla, C., Ferreira, L. (2021). "Potentiating Learning through Augmented Reality and Serious Game" *from Springer Handbook of Augmented Reality. In Press.*
2. Oliveira, J. M. C., Moura, J.M., Ferreira, F., Sylla, C. and Oliveira, E." FootMath: jogo digital com realidade aumentada para ensino de Matemática", *from Chapter 8 in Los videojuegos en la escuela, la universidad y los contextos sociocomunitários,* Editorial Octaedro, 2021. URL: https://octaedro.com/libro/los-videojuegos-en-la-escuela-la-universidad-y-los-contextos-sociocomunitarios/ , ISBN: 9788419023384.
3. Lopes, H., Carvalho, V. and Sylla, C. (2021). "Development of Tangible Interfaces for Cognitive Development: MobeyBOU" from *Chapter 3 in book Design, Applications, and Maintenance of Cyber-Physical Systems*, IGI-Global, Hershey, 2021. DOI: http://doi.org/:10.4018/978-1-7998-6721-0.ch003, ISBN:978-1-7998-6721-0.

3.5. PATENTS

1. Oliveira, B., Morais, P., Veloso, F., Moreira, A., Batista, A., Fonseca, J. and Vilaça, J.L., WO/2021/059255 – Device and operating method thereof for laser treatment of veins.

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2. Oliveira B., Morais, P. and Vilaça, J.L., Device and operating method thereof for laser tattoo removal, PP: 117076, Ref: P941.5 PP, nº 20211000006677.
3. Gomes-Fonseca, J., Vilaça, J. L., Queirós, S., Lima, E. and Correia-Pinto, J., Patent Application – 20211000016659 – Method and device for generating an uncertainty map for guide percutaneous procedures; Date: 29-04-2021. Status: Provisional patent application.
4. Gomes-Fonseca, J., Vilaça, J. L., Queirós, S., Lima, E. and Correia-Pinto, J., Patent Application – 20211000016782 – Method and device for registration and tracking

during a percutaneous procedure; Date: 30-04-2021. Status: Provisional patent application.

5. Gomes-Fonseca, J., Vilaça, J. L., Queirós, S., Lima, E. and Correia-Pinto, J., Patent Application – 20211000016772 – Surgical Navigation System for Percutaneous Renal Access: Electromagnetic Guidance and Imaging Working Together; Date: 30-04-2021. Status: Provisional patent application.

3.6. ORGANIZATION OF COURSES/WORKSHOPS

1. **2Ai Advanced Courses** - The 2021 Edition of the Advanced Courses took place from May 2021 to July 2021 in presential mode. These advanced courses aim to offer participants a specialized training characterized by the high scientific and technological potential in different areas, such as: Computer Graphics and Multimedia, Computer Engineering, Information Systems and Artificial Intelligence. The advanced courses can be attended by industry/enterprises/business professionals, academic staff, researchers, graduates and postgraduate students. In the context of the COVID-19 pandemic and the contingency plan and measures decreed by the Portuguese Government, it was possible to take the Data Analysis advanced course in presential mode, respecting health safety rules. The advanced course "Data Analysis" took place in the week between 12 and 16 July, 2021, and was attended by participants from 4 European countries (Poland, Bulgaria, France and Portugal).
   2Ai members: Miranda, D.; Vilaça, J.L.; Carvalho, V.; Gonçalves, J.; Brito, H.J.; Vilhena, E.; Simões, A.; Duarte, D.; Dias, N.

2. **2Ai Summer School** – The 2Ai Summer School took place between 27 July 2020 - 26 October 2021 (3 months) with the participation of 15 students. 2Ai organized the 2Ai Summer School which aimed to promote the development of in-person R&D activities focused on the artificial intelligence field by young researchers. The 2Ai Summer School took place on the premises of the 2Ai Laboratory, at the School of Technology (EST) of Polytechnic Institute of Cávado and Ave (IPCA). The training plan for this summer school

was divided into two components: training and research. The training component was based on short in-person thematic courses taught by integrated researchers and 2Ai collaborators. These courses focused on emerging themes of research and technological development (namely, natural language processing, deep learning for computer vision, Tiny AI, collaborative robots, simulation and, additive manufacturing) and training in basic research components (namely, research methodologies, data analysis, scientific writing, preparation of scientific pitches and funding opportunities). URL: https://2ai.ipca.pt/2ai-summer-school/.

2Ai members: Vilaça, J.L.; Morais, P.; Moreira, A.; Gonçalves, J.; Brito, H.J.; Miranda, D.; Carvalho, V.; Vilhena, E; Simões, A.

3.7. ORGANIZATION OF CONFERENCES

1. **9th International Conference on Serious Games and Applications for Health, IEEE SeGAH 2021** - to be held in Dubai, United Arab Emirates, from 4 – 6 of August 2021, at the University of Wollongong. The overall objectives of the conference are the discussion and sharing of knowledge, experiences and scientific and technical results, related to state-of-the-art solutions and technologies on serious games and applications for health and healthcare, as well as the demonstration of advanced products and technologies. URL: http://www.segah.org/2021/

   2Ai members: Duque, D.; Dias, D.; Rodrigues, N.; Vilaça J.L.

2. **Symposium on Languages, Applications and Technologies (SLATE 2021)** - 1-2 July, 2021 - SLATE is an international symposium dedicated to researchers and professionals interested in the study of languages. Since this is a very broad subject, the symposium is divided into three main tracks, each one focusing on a specific aspect of languages (Human-Human Languages, Human-Computer Languages and Computer-Computer Languages). The SLATE 2020 Conference was held virtually (Zoom conference). URL: http://slate-conf.org/2021/home

   2Ai members: Simões, A.

3. **CENTERIS – International Conference on ENTERprise Information Systems.** Already in its twelfth edition, the conference took place in Vilamoura, Algarve, Portugal, from 13 to 15 of October 2021. During this 3-day conference, under the leitmotiv of Enterprise Information Systems, academics, scientists, IT/IS professionals, managers and solution providers from all over the world have the opportunity to share experiences, bring new ideas, debate issues, and introduce the latest developments in the largely multidisciplinary field embraced by the Enterprise Information. URL: http://centeris.scika.org/

   2Ai members: Cruz-Cunha, M.

4. **5th Symposium on Applied Research** - The SAR (Symposium on Applied Research) is a Workshop organized in the School of Technology at IPCA, where Master Degree's Students and Young Researchers are invited to present their work. All works are peer-reviewed and a final presentation in poster or oral format is performed in an Open-Day format. URL: http://web.ipca.pt/symposium/2021/.
   2Ai members: Carvalho V., Dias N., Miranda D., Morais P., Simões A., Vilaça J., Vilhena E.

5. **1st Symposium of Applied Science for Young Researchers** - SASYR, the first Symposium of Applied Science for Young Researchers, welcomes works from young researchers (master students) covering any aspect of all the scientific areas of the three research centres ADiT-lab (IPVC, Instituto Politécnico de Viana do Castelo), 2Ai (IPCA, Instituto Politécnico do Cávado e do Ave) and CeDRI (IPB, Instituto Politécnico de Bragança). The main objective of SASYR is to provide a friendly and relaxed environment for young researchers to present their work, to discuss recent results and to develop new ideas. URL: http://sasyr.ipb.pt/EN_index.html.
   2Ai members: Morais, P.; Vilaça, J.

6. **2nd International Computer Programming Education Conference (ICPEC) -** 27/28 May, 2021 - ICPEC aims to be a space frequented by teachers and researchers to discuss topics that promote new methodologies, best practices, trends, techniques and tools to improve the teaching-learning process of computer programming. The ICPEC was Virtual Conference (Zoom conference). URL: https://icpeconf.org/2021

   2Ai members: Simões, A.

7. **Special Session "Wearable Healthcare" of BIODEVICES 2021 – 14th International Conference on Biomedical Electronics and Devices -** 11/13 February, 2021, the purpose of the International Conference on Biomedical Electronics and Devices is to bring together researchers and practitioners from electronics, mechanical engineering, physics and related areas who are interested in developing, studying and using innovative materials, devices and systems inspired by biological systems and/or addressing biomedical requirements. Monitoring and diagnostics devices, sensors and instrumentation systems, biorobotics and prosthetics, micro-nanotechnologies including microfluidics systems and biomaterials are some of the technologies addressed at this conference (Online Streaming). URL: https://biodevices.scitevents.org/?y=2021

   2Ai members: Carvalho, V.

8. **Special Session "Engineering Applications for Medical and Healthcare Devices" of ICIE 2020 – 1st International Conference on Innovation and Engineering -** 28/30 June, 2021, the ICIE 2021 conference brings together academicians, professionals, business practitioners from various Engineering fields, as well as, related fields from all over the world to share their ideas, authentic research results and practical experiences. This conference will also become a platform for both academicians and professionals from multi-disciplinary interests to meet and interact with members inside and outside their own particular disciplines. URL: https://www.icie2021.com/

   2Ai members: Carvalho, V.

9. **EAI Edge-IoT 2021 - 2nd EAI International Conference on Intelligent Edge Processing in the IoT Era -** 24/26 November, 2021, the EAI Edge-IoT 2021 conference has been created as a flagship conference aiming at addressing the decentralization of contemporary processing paradigms, notably Edge processing, focusing on the increasing demand for intelligent processing at the edge of the network, which is paving the way to the Intelligent IoT Era. URL: https://edge-iot.eai-conferences.org/2021/

   2Ai members: Moreira, A.

3.8. PUBLIC DATASETS

https://2ai.ipca.pt/public-datasets/

1. **LeMe-PT:** A public corpus of Leaflets of Medicine – a corpus of leaflets collected from Infarmed and annotatted for natural language processing and data extraction.
2. **MoLa RGB CovSurv:** This repository includes the complete dataset used for the training, validation and testing tasks, in order to detect the presence or absence of mask by people in public areas.
3. **MoLa IR CovSurv:** This repository includes the complete dataset used for the training, validation and testing tasks, in order to detect the presence ou absence of mask and glasses on people, and detect the caruncle zone of people's eyes (both on a thermografic context).
4. **Target image dataset for camera calibration:** This is a dataset with images of a calibration target, taken with a variety of different cameras, from DSLR, compact, GoPro, phone cameras and Raspberry Pi. For the Cannon 6D, different lenses were used.
5. **Fire occurrence dataset with geographic data of burned areas, geographic data of land occupation and meteorological conditions:** This repository contains a dataset of forest fires in Portugal in 2017 and associated metadata of land use/land cover, digital elevation model and weather.

6. **Functional prototype for forecasting burned areas through the processing of geographic data on land use and meteorological conditions.**
7. **Dataset MoLa R10k InCar Dataset Pt1**: A dataset of real infrared images of car interiors and passenger joint position for computer vision (part 1).
8. **Dataset MoLa R10k InCar Dataset Pt2**: A dataset of synthetic infrared images of car interiors and passenger joint position for computer vision (part 2).
9. **Dataset of ornamental stone images with ground-truth classification for computer vision, in collaboration with the company Mercado da Pedra**: A dataset with images and metadata of natural stones.
10. **Video dataset of violent and non-violent scenes with groundtruth classification for computer vision**.
11. **Formula 1 car image and video dataset with groundtruth for image classification and object detection with computer vision**: A dataset of images of F1 cars for image classification and object detection.
12. **Functional prototype of image classification on FPGA devices (Intel Altera DE1-SoC)**.
13. **High, medium, and low quality football video dataset with groundtruth of player detection and tracking for computer vision**: A dataset with video in 3 quality levels with player tracking groundtruth data.

3.9. MATHEMATICAL MODELS

1. AI model to segment vascular veins in RGB images;
2. AI model to augment 3D head models with cranial deformities;
3. AI model to identify laparoscospic instruments;
4. AI model to segment head structures in 2D ultrasound images;
5. AI model to segment the left atrial appendage in 2D ultrasound images;
6. AI model based on NLP to extract clinical information from different medical sources;
7. AI system to support in medical deblistering processes;

3.10. COMPUTATIONAL APPLICATIONS

1. **LeXmart:** A tool to support the lexicographic work on language dictionaries. Link: https://lexmart.eu
2. **XeraWord:** A tool to generate multilingual sentences. Link: http://ilg.usc.gal/xeraword/
3. **SatFire:** Functional prototype for forecasting burned areas through processing geographic data of land use and weather conditions. Link: https://github.com/jhbrito/SatFire
4. **StoneRecog:** Functional prototype of automatic computer vision stone grading. Link: https://github.com/2AiBAIT/StoneRecog
5. **SatForest:** Functional prototype of land occupation classification with satellite images through computer vision, in collaboration with the company Tesselo, Lda. Link:https://github.com/jhbrito/SatForest
6. **RoboSpotter:** unctional prototype of detection and classification of violent and non-violent scenes by computer vision. Link:https://github.com/helenacorreia/RoboSpotter
7. **AlteraDE1SqueezeNet:** Functional prototype of image classification in embedded devices of the FPGA type, with implementation of the SqueezeNet neural network in Intel Altera DE1-SoC. Link: https://github.com/jhbrito/AlteraDE1SqueezeNet
8. **Tracking Soccer Players**: Functional prototype of detection and tracking of football players in variable quality videos by computer vision. Link: https://github.com/jhbrito/tracking_soccer_players
9. **Surgical navigation software:** A new and specific surgical navigation software for percutaneous renal access.
10. **SmartOrthosis:** A new software for planning and treatment personalization of deformational plagiocephaly;
11. **LAAPlugin:** A new software plugin for automated evaluation of left atrial appendage in 3D echocardiographic volumes;

12. **SmartHealthDigitalization:** A mobile software application to automatically extract relevant clinical information from different sources.
13. **SmartHealthBot:** A mobile software application with a smart bot to monitor the patient well-being and identify risk situations;
14. **MedBox:** A software application to support in deblistering process to automatically feed a medical box;
15. **HeadPose:** A software application to automatically monitor a total 8 incubators and to track the head pose.
16. **HeadTraining:** A serious games for medical training in the diagnosis of deformational plagiocephaly;

3.11. LABORATORIAL PROTOTYPES

1. Abdominal phantom model: A new phantom model to assess new surgical devices in the context of percutaneous renal access. It can be also used for training purposes.
2. Hardware unit with embedded system and multiple gas and odor sensors, for validation of tinyML algorithms.
3. Hardware unit with built-in system for coupling to an AC motor kit with an accessory to vary the effort and stability load.
4. Embedded system for capturing heart beats, blood oxygenation and temperature in the ear lobe of hospitalized patients, with BLE communication capability.
5. Robotic unit controlled by ROS2 and Jetson Nano system for navigation validation by depth estimation.
6. Object detection and reconstruction system through mmWave radar coupled to a 6 Dof robotic system.
7. Mobile and automatic inspection system by the artificial vision for coupling in textile fiber production machines.
8. Platform for monitoring and recording the various movements of a wheelchair with alerts tailored to the user.
9. Plataform for physical rehabilitation based on collaborative robot and serious games;

10. Prototype of a new sensor unit to measure optimal fit between cranial orthosis and patient head;
11. Prototype of a new magnetic-based sensor unit to perform position marking;

3.12. PILOT INSTALLATIONS

1. **LEA Game:** Temporary implementation, at the Ophthalmology Department of Santa Maria Maior Hospital E.P.E., of a computer-based testing system equipped with a serious game called "LEA Game", with the aim of detecting possible vision problems in children.

3.13. COMPLETED MASTER'S THESES

1. Carla Sofia Silva Vilaça, Gestão de fatores de riscos psicossociais numa indústria metalúrgica, Master's in Integrated Management Systems: Quality, Environment and Safety, School of Technology, IPCA (supervisor: Vilhena, E.)
2. Rita Isabel Torres Leal, Cidades Inteligentes Sustentáveis: caracterização através de indicadores, Master's in Integrated Management Systems: Quality, Environment and Safety, School of Technology, IPCA (supervisor: Vilhena, E.)
3. Tânia Marina Barbosa Peixoto, Consulta aos trabalhadores para a Segurança e Saúde no Trabalho, Master's in Integrated Management Systems: Quality, Environment and Safety, School of Technology, IPCA (supervisor: Vilhena, E.)
4. Sara Catarina Santos Silva, Impacto das novas ISO 14001:2015 e ISO 9001:2015 nos Sistemas Integrados: análise de um percurso de transição, Master's in Integrated Management Systems: Quality, Environment and Safety, School of Technology, IPCA (supervisor: Vilhena, E.)
5. Cristiana Molho, O Papel da Comunicações Integradas de Marketing no Valor de uma Marca: um estudo aplicado ao Altice Forum Braga, Master's in Organizational Management, School of Management, IPCA (supervisor: Vilhena, E.)
6. Maurício da Costa Queiroz, Extração de conhecimento dos SASUM, Master in Computer Engineering, School of Technology, IPCA (supervisor: Ferreira, L.)

7. Nuno Alexandre Freitas Dinis, Indústria 4.0 – Monitorização e visualização do chão de fábrica em Realidade Virtual, Master's in Computer Engineering, School of Technology, IPCA (supervisors: Ferreira, L. and Martinho, J.)
8. Tiago Silva, Graph Database for Sast, Master's in Computer Engineering, School of Technology, IPCA (supervisors: Ferreira, L. and Oliveira, N.)
9. Tatiana Cristina Soares da Silva, Benchmark sobre Frameworks de Machine Learning, Master's in Computer Engineering, School of Technology, IPCA (supervisors: Ferreira, L. and Quintela, H.)
10. Rolando Azevedo, Processamento de dados para monitorização e mitigação do gás radão, Master in Informatics Engineering, School of Technology, IPCA. (Supervisor: Lopes, N.)
11. Leandro Cruz, Otimização de processos Admnistrativos no âmbito de uma instituição académica, Master in Integrated Management Systems - Quality, Environment and Safety, School of Technology, IPCA. (Supervisor: Lopes, N.)
12. Guilherme Polónia Rodrigues, Wildfire Risk And Burned Area Simulator, A Deep Learning Approach, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
13. Rui Miguel Martins de Carvalho, Sistema para mapeamento e navegação da uretra através de múltiplos sensores, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Vilaça, J.L. and Miranda, D.)
14. Ricardo Rodrigues, SEE2PICK 4.0 - See Through Object Detection System For Robotic Picking Applications, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.).
15. Simão Valente, Handheld Ultrasound Guidance for Percutaneous Nephrolithotomy, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisors: Vilaça, J.L. and Morais, P.)

3.14. MASTER THESES IN PROGRESS

1. Nello Orsolon, Augmented Reality for Robot Interaction, Master's in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Duque, D. and Simões A.)

2. Carlos Oliveira, Procedural Generation of Videogame Levels using Grammars, Master's in Engineering of Digital Games Development, School of Technology, IPCA (supervisor: Simões A.)
3. Vítor Araújo, Music in Videogames, and it role in the Player Immersion, Master's in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Simões A. and C. Sylla)
4. Rui Meira, Question Answering using web-services and transformers, Master's in Engineering of Informatics, Department of Informatics, University of Minho (supervisors: Almeida, J.J. (UMinho) and Simões, A. (IPCA))
5. José Vilaça, Integração de sistemas diagnóstico em jogos digitais estudo de caso: Diagnóstico LEA, Master in Engineering of Digital Games Development, School of Technology, IPCA (supervisor: Duque, D.)
6. Andreia Mendes, Desenvolvimento de aplicação em realidade virtual para o tratamento de pacientes com esquizofrenia, Master in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Duque, D.and Carvalho, V.)
7. Bruno Matos, Jogos Cinemáticos: Quão influentes técnicas cinemáticas conseguem ser na experiência imersiva do game play em videojogos, Master in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Duque, D. and Teixeira, P.M.)
8. Diogo Pereira, Realidade Virtual como ferramenta para reabilitação, pós-AVC, dos membros superiores, Master in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Duque, D. and Carvalho, V.)
9. Eduardo Santos, Desenvolvimento de Conteúdos para Videojogos: A Importância da ligação entre jogador e personagem no media interativo, Master in Illustration And Animation, School of Design, IPCA (supervisors: Duque, D. and Albino, M.)
10. Flávio Lima, Mobeybou: Investigation of Children's Playful Interactions using Mobeybou Tools, Master in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Duque, D. and Sylla C.)
11. Jonas Gomes, O ambiente como meio transmissor de emoções no universo dos videojogos, Master in Illustration And Animation, School of Design, IPCA (supervisors: Duque, D. and Ferreira, A.)

12. Rafael Silva, Ambientes Digitais e Interativos em Realidade Virtual para crianças com Autismo, Master in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Duque, D. and Melo, M.)
13. Abílio Malheiro, O impacto do brand attachment no segmento luxury do setor automóvel: uma abordagem à marca Porsche, Master in Maketing. School of Hospitality and Tourism, IPCA (supervisor: Vilhena, E.)
14. Ana Catarina Costa, Avaliação do risco financeiro: a aplicabilidade no setor têxtil do quadrilátero urbano, Master in Management (Financial Management Branch), IPCA (supervisor: Vilhena, E.)
15. Ângela Daniela Oliveira Fontes, Participação Variável em IRS: Perceção da Comunidade IPCA, Master's in Organizational Management, School of Management, IPCA (supervisor: Vilhena, E.)
16. Helena Pereira, Avaliação de Riscos Psicossociais em Contexto do Ensino Superior Politécnico, Master's in Integrated Management Systems: Quality, Environment and Safety, School of Technology, IPCA (supervisor: Vilhena, E.)
17. Joana Gabriela da Silva Duarte, Fatores motivacionais e as diferenças geracionais: estudo de caso aplicado a trabalhadores de pequenas e médias empresas, Master's in Organizational Management, School of Management, IPCA (supervisor: Vilhena, E.)
18. Joana Sofia Azevedo, Transparência Orçamental: Participação Variável em Imposto sobre o Rendimento (IRS), Master's in Public Accounting and Finance, IPCA (supervisor: Vilhena, E.)
19. Mariana Luzia Coelho Costa, A qualidade do serviço fiscal e o sistema fiscal Português online, Master in Taxation, IPCA (supervisor: Vilhena, E.)
20. Miguel Ferreira, Fatores explicativos da evolução do preço de mercado e da rentabilidade das ações: Evidência empírica para a Euronext Lisbon, Master's in Organizational Management, School of Management, IPCA (supervisor: Vilhena, E.)
21. Patrícia Cibrão, Gestão dos Riscos Psicossociais nas Organizações: aplicação do COPSOQ II, Master's in Integrated Management Systems: Quality, Environment and Safety, School of Technology, IPCA (supervisor: Vilhena, E.)

22. Rita Feitas, Análise dos Fatores Explicativos do Nível de Endividamento: Evidência Empirica para as Empresas Não Financeiras Portuguesas, Master's in Organizational Management, School of Management, IPCA (supervisor: Vilhena, E.)
23. Sara Duarte, Fatores determinantes do endividamento: Evidência empírica para as empresas não financeiras cotadas na Euronext Lisbon, Master's in Organizational Management, School of Management, IPCA (supervisor: Vilhena, E.)
24. Vitor Moreira, O impacto da Contratação Pública na Economia Local, Master's in Organizational Management, School of Management, IPCA (supervisor: Vilhena, E.)
25. Eduardo Paulo Farinha Alves, Blockchain and traceability, Master's in Computer Engineering, School of Technology, IPCA (supervisor: Ferreira, L.)
26. Jorge Miguel de Barros Carvalho, Processo de Votação e Blockchain, Master's in Computer Engineering, School of Technology, IPCA (supervisor: Ferreira, L.)
27. José Roberto Rodrigues Rosa, Plataforma Web de Gestão de demonstradores-piloto (Living Labs), Master's in Computer Engineering, School of Technology, IPCA (supervisors: Pedro, J. and Ferreira, L.)
28. Fábio António Costa Antunes Ferreira, Reconhecimento Facial Condicionado – Impacto da ocultação por máscaras e outros adereços, Master's in Computer Engineering, School of Technology, IPCA (supervisors: Ferreira, L and Pedro, J.)
29. José Miguel Queirós Pimenta do Vale, Benchmarking de Arquiteturas Orientadas a Serviços em .NET – Estudo Comparativo entre REST, GraphQL e gRPC, Master's in Computer Engineering, School of Technology, IPCA (supervisor: Ferreira, L.)
30. Andreia Daniela da Costa Oliveira, Avaliação de Usabilidade em Aplicações Interativas de Moda com Recurso a Realidade Aumentada, Master's in Computer Engineering, School of Technology, IPCA (supervisors: Martinho, J. and Ferreira, L.)
31. Helena Isabel da Silva Brandão, Distributed Graph Databases: Estudo e Avaliação, Master's in Computer Engineering, School of Technology, IPCA (supervisor: Quintela, H. and Ferreira, L.)
32. Ricardo Machado, Job Shop Scheduling using Reinforcement Learning, Master in Informatics Engineering, School of Technology, IPCA. (supervisor: Lopes, N.)
33. Afonso Almeida, Paranoid OS: Wearable Trackers, Master in Informatics Engineering, School of Technology, IPCA. (supervisor: Lopes, N.)

34. Hugo Sousa, SatSuperRes: Desenvolvimento de uma aplicação de Super resolução para imagens satélite, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
35. Diogo Pontes, FirstRowVideoSpotter: Análise de video de transmissões televisivas de eventos desportivos, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
36. Pedro Apolinário, SatForest: Classificação Hierárquica com base em imagens de satélite, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
37. Diogo Vale, Deep Learning Network Compression for Android systems, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
38. Sérgio Gomes, SatFire3: Estimativa de área ardidas com base em imagens satélite, dados geográficos e meteorológicos, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
39. Helena Correia, SmartPhoneHeadScanner, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
40. Filipe Pereira, Fall Detection System Through Human Pose Estimation and Sound Processing, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
41. Pedro Alexandre Araújo Oliveira, Jetson Nano Deep Learning, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
42. João Petersen, Game Mechanics Influenced by Biometric Sensors, Master in Engineering of Digital Games Development, School of Technology, IPCA (co-supervisor: Carvalho, V.)
43. Pedro Sanches, Simulador de Realidade Virtual – Top Gun Analysis, Master in Engineering of Digital Games Development, School of Technology, IPCA (supervisor: Carvalho, V.)
44. Paulo Barbosa, Classificação de Técnicas de Taekwondo com Recurso a Processamento de Imagem e Machine Learning, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Carvalho, V.)

45. Rui Filipe Oliveira, Simulador Debriefing em Realidade Virtual, Master in Informatics Engineering, School of Technology, IPCA. (supervisor: Carvalho, V.)
46. Sílvia Faria, Interface em Realidade Virtual para Sistema de Treino de Pilotos de Caça F16, Master in Digital Design, School of Design, IPCA. (co-supervisor: Carvalho, V.)
47. Rute Carvalho, Desenvolvimento de uma Plataforma Digital de Gestão de Roupa para Pessoas com Deficiência Visual, Master in Digital Design, School of Design, IPCA. (co-supervisor: Carvalho, V.)
48. Fábio Ferreira, Monitorização de Técnicas de Taekwondo, Master in Mechatronics Engineering, University of Minho. (co-supervisor: Carvalho, V.)
49. Andreia Mendes, Desenvolvimento de Aplicação em Realidade Virtual para o Tratamento de Pacientes com Esquizofrenia, Master in Engineering of Digital Games Development, School of Technology, IPCA (co-supervisor: Carvalho, V.)
50. Diogo Pereira, Realidade Virtual como Ferramenta para Reabilitação, Pós-AVC, dos Membros Superiores, Master in Engineering of Digital Games Development, School of Technology, IPCA (co-supervisor: Carvalho, V.)
51. Claudino Costa, Wireless In-Ear Monitoring Device for Covid-19, Master in Electronic and Computer Engineering, School of Technology, IPCA (co-supervisor: Carvalho, V.)
52. Luís Silva, Development of a Mechatronic System to Identify and Manage Clothisn Items for Blind People, Integrated Master's Degree in Industrial Electronics and Computer Engineering, University of Minho. (co-supervisor: Carvalho, V.)
53. Nuno Filipe Matos Peixoto, Emotion Prediction through audiovisual content analysis, Master in Informatics Engineering, School of Technology, IPCA. (supervisor: Dias, N.)
54. Pedro Alexandre Miquelino da Silva, Monitor pessoal de ansiedade/stress, Master in Electronic and Computer Engineering - Automation and Robotics branch, School of Technology, IPCA. (supervisors: Dias, N. and Mendes, N.)
55. João Teixeira, Enhancing the comprehension of an atom with the use of VR for 9th grade students, Master's in Engineering of Digital Games Development, School of Technology, IPCA (supervisors: Oliveira, E. and Miranda, D.)
56. Ana Almeida, Ai SaferCobot 4.0, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)

57. Fernando Pinheiro, SENSITIVE SOFT GRIPPER FOR i4.0, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
58. Claudino Costa, SEE2PICK 4.0 - See Through Object Detection System For Robotic Picking Applications, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
59. Luís Martins, Adaptive Electrrostatic Adhesion Gripper for Textile Materials, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
60. Mário Ferreira, Digital shadow system for AI enabled condition monitoring apporach in shopfloor, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
61. João Ferreira, SEE2PICK 4.0 – TinyML System for predictive Motor Anomaly, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
62. André Giesteira, AI-Based Eletronic Nose for Predictive Maintenance, Master in Electronics and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
63. Patrícia Rodrigues, Implementação e digitalização do fluxo de informação segundo a norma NP EN ISO 9001:2015 numa trading de compra e venda de peças metálicas e plásticas, Master in Integrated Systems of Management, School of Technology, IPCA (supervisor: Moreira, A.)
64. Olga Cerqueira, AI-Based Eletronic Nose for Predictive Maintenance, Master in Integrated Systems of Management, School of Technology, IPCA (supervisor: Moreira, A.)
65. Agostinho Silva, Business Analytics Platform for Micro and Small Enterprises, Master in Informatic Engineering, School of Technology, IPCA (supervisor: Gonçalves, J.)
66. Inês Escrivães, Development of an artificial intelligence system for clinical analysis and prediction of risk episodes, Integrated Master in Biomedical Engineering, UMinho & 2Ai IPCA (supervisors: Henriques, M. and Morais, P.)
67. José Carneiro, Artificial intelligence tattoo removal treatment planning for collaborative robotic-based treatments, MSc in Industrial Electronics and Computers Engineering, University of Minho & Algoritmi & 2Ai IPCA (2Ai supervisor: Vilaça, J. L.)

68. Bruno Duarte, Robust 3D breast reconstruction and localization based on artificial intelligence for robotic guided oncological interventions, MSc in Biomedical Engineering, University of Minho & Algoritmi & 2Ai IPCA (2Ai supervisor: Vilaça, J. L.)
69. Luís Barbosa, Development of an AI System for Smart Safe Health Monitoring, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Morais, P. and Vilaça, J. L.).
70. António Real, Robot-assisted Breast Biopsy, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Morais, P. and Vilaça, J. L..).
71. Raúl Ribeiro, Segmentation and Classification of Breast Tissue in Mammograms, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Morais, P. and Vilaça, J. L.).
72. Margarida Ferreira, Breast Tumor Segmentation and Classification using Deep Learning Method, Master in Informatic Engineering, School of Technology, IPCA (2Ai supervisor: Vilaça, J. L.).
73. Nuno Costa, Modular Framework for a Breast Biopsy Smart Navigation System, Master in Informatic Engineering, School of Technology, IPCA (2Ai supervisor: Vilaça, J. L.).
74. Pedro Lobo, Intelligent Medical Document Scanning System, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Simões, A., Vilaça, J. L.).
75. Sergio Pereira, Easily Adaptable System for Inserting RFID Tags During Plastic Injection, Master in Electronic and Computer Engineering, School of Technology, IPCA (supervisor: Morais, P. and Vilaça, J. L.).

3.15. COMPLETED PH.D.'S THESES

1. Nuno Miguel Cerqueira da Costa, Self-regulation Learning in Neurofeedback Training: Effects of a Human-computer Framework to Prime Subjects with External

Stimulation, like Mindfulness, Ph.D. in Bioengineering, MIT Portugal, University of Minho. (supervisors: Dias, N. (2Ai-IPCA) and Bicho, E. (Algoritmi-UMinho))

2. João Luís Gomes da Fonseca, Surgical navigation system for percutaneous renal access: electromagnetic guidance and imaging working together, Ph.D. in Health Sciences, School of Medicine, University of Minho. (supervisors: Vilaça, J.L. (2Ai-IPCA) and Lima, E. (ICVS-UMinho))

3.16. PH.D.'S THESES IN PROGRESS

1. Eduardo Pimentel, Printable piezoresistive materials based on natural polymers for medical device applications, Ph.D. in Materials Engineering, University of Minho & 2Ai IPCA (2Ai supervisor: Miranda, D.)
2. Ricardo Rodrigues, Intelligent Digital Twin for Hyper Automation Manufacturing, Ph.D. in Industrial Electronics and Computer Engineering, University of Minho & 2Ai IPCA (2Ai supervisor: Moreira, A.)
3. Miguel Ângelo Silva Pereira, Avaliação e Análise de Paradigmas e Modelos de Gestão Global de Recursos orientados à Indústria 4.0, Ph.D. in Production and Systems Engineering, University of Minho (supervisors: Varela, M.L. (UMinho) and Cunha, M.M. (IPCA))
4. Pedro Cunha, SPERTA – Real-Time Evaluation for Top Taekwondo Athletes, Ph.D. in Industrial Electronics and Computers, University of Minho. (2Ai supervisor: Carvalho, V.)
5. Daniel Rocha, Desenvolvimento de um Sistema Inteligente de Identificação e Combinação de Vestuário para Cegos, PhD. in Industrial Electronics and Computers, University of Minho. (2Ai supervisor: Carvalho, V.)
6. Filipe Pereira, Desenvolvimento de Algoritmos de Visão Computacional para Identificação e Análise da Qualidade do Fio Têxtil em Ambiente Industrial, Ph.D. in Industrial Electronics and Computers, University of Minho. (2Ai supervisor: Carvalho, V.)

7. Ahmed Fadlelmoula, Fabrication of a New In-Vitro Diagnostic (IVD) Device Using Label Free Fourier Transform IR (FTIR) Spectroscopy to Analyse Human Blood, Ph.D. in Biomedical Engineering, University of Minho. (2Ai supervisor: Carvalho, V.)
8. Joana Vanessa Santos dos Reis, fMRI guided EEG - Neurofeedback as a therapeutic tool for treatment-resistant depression (TRD), Ph.D. in Health Sciences, University of Minho (supervisors: Dias, N. (IPCA) and Peixoto, J. B. (UMinho))
9. Fernando José da Silva Veloso, Development of a customized cranial orthosis for the correction of positional plagiocephaly, Ph.D. in Mechanical Engineering, University of Minho & ICVS (supervisors: Pinho, A.C.M (Metrics-UMinho); Vilaça, J.L. (2Ai-IPCA), and Correia-Pinto, J. (ICVS-UMinho))
10. Bruno Miguel Gomes Oliveira, Artificial Intelligence collaboration robot for patient-specific laser treatment of vascular lesions, Ph.D. in Biomedical Engineering, University of Minho & ICVS & Algoritmi & 2Ai IPCA (supervisors: Vilaça, J.L. (2Ai-IPCA), and Fonseca, J.C. (Algoritmi-UMinho))
11. Helena Daniela Ribeiro Torres, Cranial Orthosis Modeling and Treatment Outcome Prediction Framework for Infants with Deformational Plagiocephaly, Ph.D. in Biomedical Engineering, University of Minho & 2Ai IPCA (2Ai supervisors: Vilaça, J.L. (2Ai-IPCA), and Fonseca, J.C. (Algoritmi-UMinho)).
12. Ana Rita Oliveira Antunes, Monitorização da Sonolência ao Volante Com a Utilização de Técnicas Estatísticas e de Machine Learning. Ph.D. in Industrial Electronics and Computers, University of Minho & 2Ai IPCA (2Ai Supervisors: Gonçalves, J.).
13. Simão Valente, A new smart and intuitive interface for Percutaneous Nephrolithonomy guidance, Ph.D. in Health Sciences, University of Minho & 2Ai IPCA (2Ai supervisor: Vilaça, J. L.).
14. Nuno Rodrigues, Enhanced Surgical Rooms for Robotic-Guidance Urologic Interventions, Ph.D. in Health Sciences, University of Minho & 2Ai IPCA (2Ai supervisor: Vilaça, J. L.).
15. Marcos Fernández Rodríguez, New AI-assisted interfaces for improved surgical rooms, Ph.D. in Health Sciences, University of Minho & 2Ai IPCA (2Ai supervisor: Vilaça, J. L.).

16. Bruno Silva, Deep Learning Networks for Semantic Segmentation of Anatomical Structures in Laparoscopic Surgery, Ph.D. in Health Sciences, University of Minho & 2Ai IPCA (2Ai supervisor: Vilaça, J. L.).
17. Isaías Barbosa, "Sistema de alerta inteligente para doentes ostomizados", Ph.D. in Industrial Electronics and Computers, University of Minho & 2Ai IPCA (2Ai Supervisors: Vilaça, J.L.)

3.17. BACHELOR FINAL PROJECTS

1. João Ribeiro, Classificação morfológica do apêndice auricular esquerdo utilizando deep learning – Um estudo de viabilidade, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Morais, P. and Vilaça, J.L.)
2. João Azevedo, Desenvolvimento de um método de Deep Learning para segmentação do apêndice auricular esquerdo em Ecocardiografia 2D, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Morais, P. and Vilaça, J.L.)
3. Carlos Freitas, Satfire2 - Forest fire dataset and burned area prediction using geographical and weather data, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
4. Ricardo Rodrigues, Remote Supervisor System for Industrial Machine, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
5. Henrique Costa, Yarn Sensor, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
6. João Fernandes, Fruit SoftGripper, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
7. Marco Calheiros, Ai Knitting Supervisor, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
8. João Arantes, Automotive Ai Interaction, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)

9. César Freitas, AITex Inspection, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
10. Joao Silva, Structured Genetic Pruning for Deep Convolutional Neural Networks, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
11. Rui Fernandes, Phone Scanner: Mobile Device Data Acquisition System for Human Body Dataset Building, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H. and Vilaça, J.L.)
12. Joao Rodrigues, AutoAi Sense for lost objects in contact surfaces, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
13. Pedro Guimarães, E-Sensor for Road Condition, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
14. Joaquin Andres da Silva Dillen, Soil-based Thermoelectric Energy Harvesting System for IoT Devices, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
15. Nuno Fernandes, Sistema de inspeção por visão artificial para deteção de anomalias em peças metálicas, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
16. Ivo Dias, Digital Gauge – an embedded tinyML approach for efficient remote monitoring, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
17. Fábio Oliveira, Physio Motion Transfer: A retargeting approach to transfer human motion and appearance in monocular videos for physiotherapy applications, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
18. André Torneiro, WBG: Words by Gestures Emergency Line for hearing impaired community, Bachelor's degree in Electrical and Computer, Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)

19. Rui Cruz, Melhoramento de máquina têxtil – Espremedor, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
20. Humberto Costa, Wireless Mesh based adaptative Interactive Play & Learning System, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Moreira, A.)
21. Eloi Martins, Soccer Player Tracking in Low Quality Video, Bachelor's degree in Electrical and Computer Engineering, School of Technology, IPCA (supervisor: Brito, J.H.)
22. Paulo Silva, Aplicação Android para Testes de Performance de base de dados, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Simões, A.)
23. Carlos Ribeiro, Extração de Informação de Relatórios Médicos, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Simões, A.)
24. Daniel Silva, Escalonamento de Produção usando técnicas de Machine Learning, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Lopes, N.)
25. Ricardo Ferreira, Construção de processos de negócio, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Lopes, N.)
26. José Alves, Aplicações Móveis Híbridas, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Ferreira, L.)
27. Francisco Ferreira, Sistema de Votação de Delegados, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Simões, A.)
28. Carlos Miranda, Aplicação Mobile para Deteção/Reconhecimento de Informação Analógica, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisors: Simões, A. and Duque, D.)
29. Sara Oliveira, Rede Social Médica, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Simões, A.)
30. Hugo Loureiro, Aplicação Mobile para Deteção/Reconhecimento de Informação Analógica, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisors: Simões, A. and Brito, J.H.)

31. Tiago Rodrigues, LeXmart, Bachelor's degree in Computer Systems Engineering, School of Technology, IPCA (supervisor: Simões, A.)

4. FUNDING

4.1. FUNDING APPLICATION

R&D Industrial Projects in National Calls

Pacto para a Saúde

Call: Grant N.º 01/C05-i01/2021

2Ai Members: João L. Vilaça, Vitor Carvalho, Pedro Morais, António Moreira, Duarte Duque, Alberto Simões, João Fonseca

Requested Funding to 2Ai: 1.666.152,00€

R&D Partners: Prológica

Status: Under Evaluation.

Agenda para a construção industrial sustentável

Call: Grant N.º 01/C05-i01/2021

2Ai Members: João L. Vilaça (PI), António Moreira, Pedro Morais, Duarte Duque, Daniel Miranda, André Carvalho, João Fonseca

Requested Funding: 1.326.443,43€

Requested Funding to 2Ai: 742.154,74€

R&D Partners: Casais

Status: Under Review.

CR300 - Comunidades de Energia + Resilientes

Call: Grant N.º 01/C05-i01/2021

2Ai Members: Duarte Duque (PI), Alberto Simões, Vitor Carvalho, João L. Vilaça

Requested Funding to 2Ai: 471.890,60€

R&D Partners: About Energy, CleanWatts, OneCare, ISR-UC, CASPAE, GripWise

Status: Not Recommended for Funding.

Health Data Hub

Call: Grant N.º 01/C05-i01/2021

2Ai Members: Joaquim Gonçalves

Requested Funding to 2Ai: 818.311,60€

Status: Not Recommended for Funding.

R&D Projects in national calls

AiPreventis - Artificial intelligence platform for detection and preventive diagnosis of dental diseases

Call: FCT I&D Projects

2Ai Members: António Moreira (PI), João L. Vilaça, Pedro Morais

Requested Funding: 249.739,25€

Requested Funding to 2Ai: 212.265,00€

R&D Partners: Algoritmi and Universidade Católica Portuguesa

Status: Not Recommended for Funding.

Three dimensional printed Batteries for Advanced Electronics Applications

Call: FCT I&D Projects

2Ai Members: Daniel Miranda, João L. Vilaça

Requested Funding: 242.986,49€

Requested Funding to 2Ai: 15.171,40€

R&D Partners: Centro de Física da Universidade do Minho and Centro Requenti da Universidade Nova de Lisboa

Status: Not Recommended for Funding.

Personalised digital cognitive therapy

Call: FCT I&D Projects

2Ai Members: Nuno Rodrigues (PI) and Eva Oliveira

Requested Funding: 201.457,48€

Requested Funding to 2Ai: 132.442,60€

R&D Partners: CIPsi/UMinho

Status: Not Recommended for Funding.

Ecologia das interações gado-lobo

Call: FCT I&D Projects

2Ai Members: Luís Ferreira

Requested Funding: 249.559,79€

Requested Funding to 2Ai: 42.992,50€

R&D Partners: FCiências.ID (Proponent), Asociación Galega de Custodia de Territorio, Grupo Lobo, Iberian Wolf Research Team, Universidad de Oviedo

Status: Not Recommended for Funding.

Leveraging Artificial Intelligence Improve Minimally Invasive Inguinal hernia repair in children

2Ai Members: João L. Vilaça

Call: FCT I&D Projects

Requested Funding: 250.000,00 €

Requested Funding to 2Ai: 24.630,00 €

R&D Partners: ICVS/3B's Associated Laboratory PT (Proponent)

Status: Not Recommended for Funding.

LASERNAVI - Intelligent collaborative system for laser treatments

2Ai Members: João Vilaça (PI), Pedro Morais, António Moreira

Call: FCT I&D Projects

Requested Funding: 249.756,80 €

Status: Not Recommended for Funding.

SmartLAAC - Smart image-based system for device implantation planning, sizing and guidance in Left Atrial Appendage Closure

2Ai Members: Pedro Morais (PI), João Vilaça, António Moreira, João Fonseca

Call: FCT I&D Projects

Requested Funding: 249.783,81€

Requested Funding to 2Ai: 224.724,26€

R&D Partners: ICVS/3B's Associated Laboratory PT, CUHK, UKBonn and KULeuven

Status: Not Recommended for Funding.

SPERTA - Real-time Performance Assessment System for High-Competition Taekwondo Athletes

2Ai Members: Vitor Carvalho (PI)

Call: FCT I&D Projects

Requested Funding: 210.935,40€

Requested Funding to 2Ai: 210.935,40€

R&D Partners: UMinho.

Status: Not Recommended for Funding.

Institutional Projects

Knowledge Circle

2Ai Members: André Carvalho and João L. Vilaça

Call: POCI-46-2021-11

Requested Funding: 477.810,74€

Requested Funding to 2Ai: 231.229,04€

R&D Partners: Polytechnic Institute of Leiria

Status: Recommended for Funding.

IPCA-VIC- Valorization and Innovation Center

2Ai Members: João L. Vilaça (PI), Pedro Morais, André Carvalho

Call: Norte-46-2021-52 - Infraestruturas tecnológicas da região Norte - Centro de Valorização e Transferência de Tecnologia - Universidades e Institutos Politécnicos.

Requested Funding to IPCA: 2.352.941,18€

Status: Under Evaluation

European Projets (Horizon2020)

RUN-EU+ - Professional Research Programmes for Business and Society

Call: H2020-IBA-SwafS-Support-2-2020.

Partners: Technological University of the Shannon: Midlands MidWest (Ireland, Proponent), Polytechnic Institute of Leiria (Portugal), Häme University of Applied Science (Finland), Széchenyi István University (Hungary), NHL Stenden University Of Applied Sciences (Netherlands), Vorarlberg University of Applied Sciences (Austria).

2Ai Members: João L. Vilaça, Pedro Morais.

Total Funding of IPCA: 184.910,00€.

Status: Recommended for funding.

AIMLearning - Adaptive and Immersive Technologies for Enhancing Learning in Vocational Education and Training

Call: HORIZON-CL2-2021-TRANSFORMATIONS-01.

Partners: Häme University of Applied Science (Finland, Proponent), Technological University of the Shannon: Midlands MidWest (Ireland), Stiching NHL Stenden Hogeschool (Netherlands), Universitaet Siegen (Germany), Eidgenossisches Hochschulinstitut fur Berufsbildung (EHB, Switzerland), Technological University of the Shannon - Midlands Midwest (TUS), Ammattioaamisen Kehittamisyhdistysamke RY (Finland), European Forum of Technical And Vocational Education and Training

(Belgium), Committee of the Dublin West Education Centre (Irland), Suomen eOppimiskeskus ry (Finland).

2Ai Members: João L. Vilaça, Pedro Morais, Vítor Carvalho, António H. J. Moreira

Total Funding of 2Ai: 250,050.80 €

Status: Under Evaluation.

4.2. FUNDING COLLECTED

I&D project - Public call

OncoNavigator - Intelligent system for personalized navigation and mapping of oncological interventions

Aims: This project aims to develop a wearable device, ease to use and with several physiological sensors, combined with an environmental control station that, through artificial intelligence (AI), allows the remote detection of signs of pathological conditions such as COVID-19 Infection, as well as remote monitoring of the elderly in their home environment.

Principal Investigator in 2Ai: João L. Vilaça

Reference: NORTE-01-0145-FEDER-000059

Period: 2021-2023.

Total Funding: 587.995,42€

SAFHE - Safe Health Elderly Monitoring

Aims: This project aims to develop a wearable device, ease to use and with several physiological sensors, combined with an environmental control station that, through artificial intelligence (AI), allows the remote detection of signs of pathological conditions such as COVID-19 Infection, as well as remote monitoring of the elderly in their home environment.

Principal Investigator in 2Ai: Pedro Morais

Reference: NORTE-01-0247-FEDER-070200

Period: 2021-2023.

Partner: Plux (Proponent) and Polytechnic Institute of Porto (ESS and Portic).

Total Funding: 673.454,67€

Total Funding of 2Ai: 207.308,08€

IMPACTV - Impacto eMocional e Previsão de Audiências de Cinema na TV

Aims: The goal of the project focuses on developing a new tool, a pet model churn hearings, which will incorporate the platform current of average testing of MindProber technology, and so allow present a probability, the second loss audiences during the content and have a full conversion probability in the case of selfpromotions or advertising content. It is also objective the development of a new platform to date-the-a-Service, the DaaS - PALM (Physiological Assessment of Live Media), which will provide customers with a view (weekly) the commercial value of space television regarding its ability to promote the emotional involvement of viewers (Spotscore index) and, consequently, to model the reaction to commercial material (promos , sponsoring) inserted in these media.

Principal Investigator in 2Ai: Estela Vilhena

Reference: Operation No. 68574 (Call 17/SI/2019)

Period: 2022-2023.

Partner: MindProber (Proponent) and NOS.

Total Funding: 795.845,11€

Total Funding of 2Ai: 167.877,33€

Raid Piracy 2020

Aims: The RAID.Piracy project aims to create an anti-piracy solution based on a disruptive technological architecture based on machine learning and artificial intelligence that is efficient, scalable, comprehensive and adaptive in mitigation of the illicit distribution of audiovisual content. The activities within the project under the responsibility of the 2Ai/IPCA, are tasks related to research in video and audio analysis of television broadcasts of sporting events.

Principal Investigator in 2Ai: José H. Brito

Reference: Operation No. 446964 (Call 17/SI/2019)

Period: 2022-2023.

Partner: WEDO (Proponent) and NOS.

Total Funding: 1.257.933,39€

Total Funding of 2Ai: 224.427,63€

Research and innovation support projects (institutional Projects) - Public call

Knowledge Circle

Aims: To transfer results stemming from scientific and technological research to organizations and the wider society, along with associated skills and procedures to create utility for the ones who benefit from the use of the project outcomes.

Reference: Call n.º 04/SIAC/2021 - Transfer of scientific and technological knowledge, POCI-46-2021-11

Period: 2021-2023

Partner: Polytechnic Institute of Leiria (Proponent)

Total Funding: 477.810,74€

Total Funding of 2Ai: 231.229,04€

RUN-EU+ - PROFESSIONAL RESEARCH PROGRAMMES FOR BUSINESS AND SOCIETY

Aims: RUN-EU+ aims to complement the RUN-EU European University action plans, in developing an integrated long-term strategy for research and innovation (R&I) within our European University and in addition will develop a framework and programmes at MSc and PhD levels across the network. The RUN-EU+ R&I strategy will fundamentally reinforce the RUN-EU cooperation in R&I with other sectors, particularly with academia-business collaboration in the RUN-EU focus areas. RUN-EU+ will also define the roadmap for the development of Collaborative Professional Practice-based Research and the implementation of guidelines for European research careers.

Principal Investigator in 2Ai: João L. Vilaça

Reference: Grant No. 101035816 (Call H2020-IBA-SwafS-Support-2-2020)

Period: 2021-2024.

Partner: Technological University of the Shannon: Midlands MidWest (Proponent), Polytechnic Institute of Leiria, Häme University of Applied Science, Széchenyi István University, NHL Stenden University Of Applied Sciences, Vorarlberg University of Applied Sciences.

Total Funding: 1.998.061,25€

Total Funding of IPCA: 184.910,00€

5. SHORT ADVANCED PROGRAMS

1. Data Analysis

Description: This short advanced program targeted the following topics, namely: sensitize participants about the importance of extracting knowledge from unstructured data, especially when the data volume is very large; provide knowledge of the main data analysis techniques using statistical software; formulate and solve problems, interpret results based on statistical tools, related to: forecasting models, reducing data complexity, classifying and grouping objects or variables; understand the concept of machine learning and select the most appropriate models for each problem and develop logical and deductive reasoning; increase critical spirit, develop analytical and creative ability.

2Ai Members: Estela Vilhena (2Ai-IPCA) and Joaquim Gonçalves (2Ai-IPCA)

Date: July 2021

Organization: 2Ai-IPCA

Webpage: https://2ai.ipca.pt/advanced-courses/data-analysis/

Figure 1 – Participants of our first 2Ai Advanced Course – Data Analysis

2. Game Changing Games

Description: 'Game Changing Games' is a RUN-EU Short Advanced Programme (SAP) jointly coordinated by Vorarlberg University of Applied Sciences (FHV) and

Polytechnic of Cávado and Ave (IPCA). It aims to understand how game designers can address the most urgent global challenges and incite change, by fostering the sustainable co-existence of humans and the ecological systems. Creating games that motivate people to engage with social issues in a playful way could be one way of making critical issues easier to perceive.

2Ai Members: Alberto Simões (2Ai-IPCA)

Date: October 2021 - November 2022

Organization Leader: Vorarlberg University of Applied Sciences and 2Ai-IPCA

Webpage: https://run-eu.eu/2021/07/22/sap-game-changing-games

Figure 2 – Flyer of the co-organized Short Advanced Programme: Game Changing Games

3. **Design Expedition: Emotional Intelligent Meets Artificial Intelligence in Business Design**

Description: 'Design Expedition: Emotional Intelligence Meets Artificial Intelligence' is a RUN-EU Short Advanced Programme (SAP), jointly coordinated by HAMK and IPCA, offering an experimental learning journey to emotions and artificial intelligence during a 1-week online workshop, from 8 to 15 February 2021. All RUN-EU students from any level of studies are invited to participate. Participants will be grouped into multidisciplinary and multicultural teams. The challenge is to create a solution for the interactive future customer experience of a grocery store visitor. Participants must create a solution that encompasses the possibilities connected but not limited to Computer Vision, Emotional Intelligence

and Artificial Intelligence Applications.

2Ai Members: Alberto Simões (2Ai-IPCA), Duarte Duque (2Ai-IPCA), João L. Vilaça (2Ai-IPCA), José Brito (2Ai-IPCA)

Date: February 2021

Organization Leader: HAMK and IPCA

Webpage: https://run-eu.eu/2021/01/19/short-advanced-programme-sap/

Figure 3 – Flyer of the co-organized Short Advanced Programme: Design Expedition.

6. PRIZES

Challenge: COVID-19 Lung CT Lesion Segmentation Challenge

Date: January 2021

Website: https://covid-segmentation.grand-challenge.org

Prize: Finalist, top 10

Team: Oliveira, B., Torres, H., Morais, P., Veloso, F., Fonseca, J.C., Vilaça, J.L.

Challenge: HeiChole Surgical Workflow Analysis and Full Scene Segmentation (HeiSurF)

Date: October 2021

Website: https://www.synapse.org/#!Synapse:syn25101790/wiki/

Prize: Winner Instrument Detection; 2nd Phase Recognition; 2nd Action Recognition

Team: Oliveira, B., Torres, H., Morais, P., Veloso, F., Fonseca, J.C., Vilaça, J.L.

Challenge: Surgical Action Triplet Recognition 2021

Date: October 2021

Website: https://cholectriplet2021.grand-challenge.org/CholecTriplet2021/

Prize: Finalist

Team: Oliveira, B., Torres, H., Morais, P., Fonseca, J.C., Vilaça, J.L.

Challenge: Fetal Brain Tissue Annotation and Segmentation Challenge (FeTA)

Date: October 2021

Website: https://feta.grand-challenge.org/

Prize: Finalist, 7th

Team: Torres, H., Oliveira, B., Morais, P., Fonseca, J.C., Vilaça, J.L.

7. RESEARCH COLLABORATION AGREEMENTS

The following protocols were established in 2021:

- **Laboratory for Cardiac Imaging and 3D Printing, Faculty of Medicine, The Chinese University of Hong Kong (CUHK)** - The current protocol defines a set of guidelines for joint research between 2Ai-IPCA and the Laboratory for Cardiac Imaging and 3D Printing of CUHK in cardiac imaging fields.

- **Hospital de Barcelos** - The current protocol focuses on joint research collaboration in health-related areas.

- **Casa São João de Deus** - This protocol targets joint research collaboration in mental health-related areas.

- **Escola Secundária Henrique Medina -** This protocol aims to cooperate and collaborate with the secondary school within the scope of the promotion and development of educational activities planned by the Escola Superior de Tecnologia (EST) and its respective R&D Unity Research (2Ai), with the main goal is to bring schools closer to sources of knowledge and technology, fostering a closer link between schools and the scientific community.

- **Agrupamento de Escolas Rosa Ramalho** - This protocol aims to cooperate and collaborate with the secondary school within the scope of the promotion and development of educational activities planned by the Escola Superior de Tecnologia (EST) and its respective R&D Unity Research (2Ai), with the main goal is to bring schools closer to sources of knowledge and technology, fostering a closer link between schools and the scientific community.

8. SCIENTIFIC RECRUITMENT

8.1. SCHOLARSHIPS

During this year, 2Ai opened multiple tenders in order to increase the critical mass in the R&D unit. Different scholarship typologies, according to the researcher's degrees, were offered. A summary of the research opportunities can be found in Table 2. All scholarships were funded by ongoing projects in the R&D. Research positions in all scientific levels (as defined by the Portuguese Foundation for Science and Technology) were offered. It must be emphasized that a total of 3 scholarships for Ph.D. candidates (1 funded by the Portuguese Foundation for Science and Technology and 2 funded by private partners) were also released.

Table 2 - Number of scholarship tenders opened in 2020

Scholarship	Nº of Positions
Research initiation scholarship	0
Research scholarship for bachelors	23
Research scholarship for masters	1
Ph.D. scholarships	3
Post-doctoral scholarships	1

8.2. SCIENTIFIC EMPLOYMENT

An international selection tender for recruitment in the form of an uncertain term contract concluded under the Labour Code, of 1 (one) Junior Researcher position for the exercise of scientific research activities in the scientific area of Engineering, Artificial Intelligence and Biomedical Sciences was opened. It was published in the Portuguese Diary of the Republic, 2nd Serie, nº 111, with reference 16865/2021.

During the tender period, one application was received, which was selected for the JuniorResearcher position. The Researcher initiated its activities in December 2021.

This position was opened under the project OncoNAVIGATOR — Intelligent System for personalized navigation and mapping of oncological interventions, operation no. NORTE-01-0145-FEDER-00059 (Call NORTE-45-2020-75 Support System for scientific and technological research - Structured Projects of R&D&I" — HORIZON EUROPE) funded by NORTE2020, Northern Regional Operational Programme, through Portugal 2020 and the ERDF (European Regional Development Fund). Moreover, the current research opportunity is in accordance with national politics to promote research careers in Portugal, namely the Scientific Employment program.

9. PH.D.'S DEGREE

During 2021, the Doctoral Programme in Games and Creative Technologies (submitted in 2020) was accepted by the Portuguese Higher Education Evaluation and Accreditation Agency. This doctoral programme is a collaboration between 2Ai and School of Technology from IPCA and UNIDCOM and Faculty of Design, Technology and Communication from European University. The proposed doctoral program explores the interdisciplinarity of video games and digital entertainment, aiming to provide advanced and specialized training. The doctoral program will start in 2022-2023.

As a short summary, this Ph.D. aims to provide its students with knowledge and methodological skills related to research activities, but, at the same time, aims to offer real experience in research and development projects. Thus, the involvement of doctoral students in research and development projects that are taking place within the research centers associated with this program, will be pursuit. In addition to research projects, there will also be an attempt to involve partners from the creative industries, with the aim of creating awareness about the role of doctoral profiles in the industry and the value they can create. In this way, it promotes applied research, whether through the use of games as a tool to deal with real-world problems, either through innovation in design, or through the development of new technologies and processes for the creative industry.

10.MASTER'S DEGREE

10.1. NEW APPLICATION

In October 2021, a new Professional Master's degree in Supporting Technologies for STEAM Education was submitted to evaluation by the Portuguese Higher Education Evaluation and Accreditation Agency.

The new Master's course has a duration of 4 trimester, corresponding to a total of 60 ECTS. It integrates a final project corresponding to 30 ECTS credits, *i.e.* 50% of the total number of credits of the proposed course.

Although the course is targeted to primary and secondary school teachers, it has predominantly a technological nature. The course aims to train its students to study a set of technologies that enable them to develop digital educational resources, with a view to their inclusion in the teaching and learning processes. In this context, 90% of the Curricular Units refer to the Scientific Areas of Computer Graphics and Electrical Engineering.

The curricular units are organized into three trimester modules, in conjunction with an annual Project curricular unit. With this curricular structure, it is intended that, in each of the first three quarters, students acquire a set of skills and put them into practice in the schools where they develop their professional activity.

Thus, the first trimester aims to train students to use software technologies with a view to produce new educational content, using high-level tools that allow the development of graphically appealing applications and the use of innovative technologies, such as Augmented Reality. Research methodologies that allow the application of scientific methodology in the development and validation of their work will also be addressed. The inclusion of technologies in pedagogical practice will be guided by a curricular unit in charge of the University of HAMK, Finland (RUN-EU partner).

The second trimester will address the hardware aspect. Here, the students are expected to design and implement simple electronic systems, as well as, evaluate and adapt kits available on the market. The inclusion of technologies in pedagogical practice will be guided by a curricular unit in charge of the University of HAMK, Finland.

Finally, the third trimester will be dedicated to the implementation of gamification techniques in the teaching methodology. Students are expected to make use of the knowledge acquired in the previous two trimesters, creating innovative learning activities in one of the STEAM areas. The pedagogical dimension will be guaranteed by a CU, "Integrated Laboratories - Pedagogical Dimension III", in charge of the University of HAMK, Finland.

10.2. ONGOING

In 2021, the Master in Applied Artificial Intelligence (https://m2ai.ipca.pt/), developed in conjunction with 2Ai and the IPCA Higher School of Technology, was recognized by the Portuguese Higher Education Evaluation and Accreditation Agency. The current master program started in November 2021. In the first edition, it had a total of 10 students.

This master's degree is taught in English and works in a modular way, where each module requires laboratory rotations of students in ongoing research projects at 2Ai. This aspect is critical to reinforce the critical mass of 2Ai, while it will enable it to fulfill the mission of 2Ai in supporting the training of highly qualified staff within its area of intervention.

The general objectives of this master's degree correspond to the introduction of artificial intelligence concepts to its students, as well as the exploration of the use of artificial intelligence in different areas, from electronics, computer vision, processing natural language, among others.

The first edition of this master also received support from external companies, namely Delloite. Here, the selected students for the master's will have the opportunity to establish a professional contract with Deloitte, which financially supports their training and guarantees its integration in the working market.

11. ASSOCIATED LABORATORY

A general overview of the associated laboratory is presented next.

Name: Associate Laboratory of Intelligent Systems (LASI)

Identification: LASI - LA/P/0104/2020

LASI Budget: 135.741,90€

2Ai Budget: 0,00€

Status: Accepted

Abstract: Since the dawn of times, the human being has always endeavoured to improve his quality of life. We, at the forefront of this technological evolution, must be ready to push the boundaries of knowledge and allow our world to go for a better future. No monolithic solution will, singularly, settle out all problems. Instead, the expectation is that multiple small contributions may help to answer important challenges. Ergo, the creation of the Intelligent Systems Associate Laboratory here depicted, coordinated by the ALGORITMI Centre, and composed by 13 R&D units that go from Barcelos, Braga and Guimarães to Porto, Aveiro, Coimbra, and Lisbon. All these units, strongly consolidated in the international scientific landscape, have a rich relationship with the domains of artificial intelligence and data science, going from the theoretical foundations to its practical application. Our contribution is grounded on the perception of people as active actors of the technological ecosystem, with every individual being part of a more innovative, sustainable, and inclusive society, where gender equality assumes increased importance, giving answer to challenging public policies. This aids the emergence of Smart Cities, since this connected society allows one to push the boundaries of knowledge in domains such as public administration and egovernance, public transportation systems, renewable and green energy, public health and well-being, and go for innovative and sustainable solutions that, in the end, aim to improve the quality of life of every individual. The inclusion of people as active actors allows one to settle and develop not only Industry 5.0, but also go for Health and Society 5.0, with significant cooperation between humans and machines, and with a graceful harmony between human intelligence and artificial one. Therefore, the adopted research methodology will focus on the organization of a logical sequence of

replicable, precise, and transparent procedures to build scientific knowledge and software artefacts that, by making use of multiple innovative and disruptive methods, models, and technologies, will materialize the proposed objectives. This Associate Laboratory will strongly endeavour to promote scientific employment, guaranteeing, in five years, that LASI holds, at least, 55 Ph.D. researchers under permanent contracts, with national and international talent attraction and the ability to raise competitive funding being some of our historical strengths.

Current Point of Situation: The Associated Laboratory was accepted and recommended for funding in February 2021 by the Portuguese Foundation for Science and Technology. LASI is one of the 40 Portuguese Associated Laboratories.

12. DIGITAL INNOVATION HUB

2Ai/IPCA integrated the ATTRACT DIH proposal (already accepted), ArTificial InTelligence and High-PeRformAnce CompuTing @ Portugal Digital Innovation Hub. The ATTRACT consortium intends to establish itself as a collaborative network, benefiting from the strong skills, complementary infrastructures and capabilities and experience of developing innovative solutions of its members, in the digital area, namely in cooperation with companies and sectors. Its main objective is to promote the development and adoption of new solutions based on advanced technologies of Artificial Intelligence (Artificial Intelligence - AI) and High-Performance Computing (HPC). It also intends to act as a proactive driver of the innovation ecosystem, supporting and interconnecting the target audiences, users, and technological recipients, whether SMEs, start-ups, or Public Administration entities. It is therefore proposed to collaborate with these entities not only in the development, testing, experimentation and validation of new products and services based on these technologies, but also in the search for related investment and in the training and qualification of human resources. This form of action will be complementary to the market offer, with non-profit ends.

For that, ATTRACT brings together the main centers of competence in these technologies in Portugal, including Technological Interface Centers, a Collaborative Laboratory, Universities and Polytechnic Institutes. It includes the universities of Aveiro, Coimbra, Évora, Lisbon (FCiências.ID and Instituto Superior Técnico), Minho, Porto and Trás-os-Montes and Alto Douro, the Polytechnic Institutes of Cávado and Ave and Porto, the Iberian Institute of Nanotechnologies, the Pedro Nunes Institute, the National Civil Engineering Laboratory, DTx and INESC TEC.

As a future goal, The ATTRACT DIH consortium intends to integrate the European Network of Digital Innovation Poles with the aim of facilitating access to skills and experimentation infrastructure that do not exist in Portugal.

13.RUN-EU REGIONAL UNIVERSITY NETWORK

Since 2020, IPCA integrated the Regional University Network (RUN-EU) European Universities, funded under the Erasmus + and Horizon 2020 Programs. The project established a consortium led by the Polytechnic of Leiria (Portugal) and composed of the following founding members: Polytechnic of Cávado and Ave (Portugal), Limerick Institute of Technology (Ireland), Athlone Institute of Technology (Ireland), Széchenyi István University (SZE) (Hungary), Häme University of Applied Sciences HAMK (Finland), NHL Stenden University of Applied Sciences (The Netherlands), and FH Vorarlberg University of Applied Sciences (Austria).

The Regional University Network (RUN-EU) aims to implement training programs that include the promotion of future and advanced skills for social transformation in the regions of the European Union. Higher Education Institutions will jointly develop a diverse range of teaching and learning actions, providing students with different international programs (short-term and e-learning), while international cooperation projects in the area of research and development are also implemented. In the future, students will also have the opportunity to obtain European double/multiple degrees within the framework of joint training programs.

Specifically, 2Ai members are integrated into different work packages of the project, highlighting the participation in WP5 (RUN-EU Discovery Program) as co-leader and the leadership of the joint research projects in Health. Moreover, during 2021, 2Ai/IPCA in cooperation with the remaining RUN-EU members submitted the project RUN-EU+ - Professional Research Programmes for Business and Society, already recommended for funding by the H2020 program. Further details on this project are presented in the next sub-section.

13.1. RUN-EU+

RUN-EU PLUS - Professional Research Programmes for Business and Society (RUN-EU+) aims to complement the RUN-EU European University action plans (avoiding replication), in developing an integrated long-term strategy for research and innovation (R&I) within the RUN-EU University and in addition will develop a framework and programmes at M.Sc. and Ph.D. levels across the network. The RUN-EU+ R&I strategy will fundamentally reinforce the RUN-EU members cooperation in R&I with other sectors, particularly with academia-business collaboration in the RUN-EU focus areas of Future Industry and Sustainable Regional Development, the Bio-economy and Social Innovation. The Regional University

Network – European University (RUN-EU) alliance brought together eight like-minded, regionally focused Higher Education Institutions (HEIs) and our mission implementation plan set out a delivery mechanism for the creation of a new multinational interregional alliance and a European Zone for Interregional Development (EZ-ID). RUN-EU+ will be a true European engine of R&I for regional development, utilising the quadruple helix approach in the collaborative co-design and co-creation of our research, innovation, pedagogical and social engagement activities. Specifically, RUN-EU+ will develop a Common R&I Agenda and Collaborative Action Plan, in synergy with the consortium's education strategies and regional engagement initiatives detailed within the 'Interuniversity Future and Advanced Skills Academies', 'European Innovation Hubs' and 'European Mobility Innovation Centre' of our original proposal.

RUN-EU+ will define the roadmap for the development of Collaborative Professional Practice-based Research Masters and Ph.D. Programmes. These will be accredited, scalable, interdisciplinary and focused on Business and Society. This will include social and cultural innovation, complementing the agenda of the 'European University Initiative', facilitated through engagement with our stakeholder clusters to strengthen academia-business cooperation, sharing of knowledge, identification of specialist skills needs and the valorization of the entrepreneurial mindset amongst our research community. An Economic Resource/Assessment Model will also be developed to ensure scalability and long-term sustainability.

The identification of regional innovation strategies and specialization will inform the design of Professional Practice-based Research Masters and Ph.D.s and the creation of expert University Supervision Teams. In strengthening the innovation capacity RUN-EU+ will design accredited professional development programmes for work-based supervisors, advisors and mentors, in collaboration with our regional stakeholders available through the University's cloud of knowledge portal. In mainstreaming our R&I entrepreneurship and transversal skills we will design a suite of seminars, workshops, bootcamps and summer schools that will equip researchers at all career stages with the necessary tools and skills to research and implement innovation. RUN-EU+ will thus build challenge-based interdisciplinary knowledge-creation ecosystems of learning including students,

researchers, public and private sector stakeholders and the RUN-EU+ cloud of knowledge shared platform for pooling our expertise, data and resources. A Research and Innovation Ambassadors network, supported by an Innovation, Research and Development Facilitator, will also be created to consolidate the connection of the 'University' with other actors of the ecosystem including, agencies, investors and the wider business community.

RUN-EU+ is also intent on implementing strategies to strengthen RUN-EU human capital resources in R&I. Ensuring excellent research is acknowledged to be vastly improved by investing in researchers' talents, skills and career development. It is widely acknowledged that human capital is a critical factor in reaping economic and social rewards from investment in research. RUN-EU members will develop a Research Career Development Programme adhering to the European charter and code principles as part of this project to support our researchers in identifying clear personal career paths which will encourage inter-sectoral and international mobility during their careers. This programme will be supported from the original RUN-EU work plan specifically within WP 4 (European Mobility Innovation Center) and WP 5 (RUN-EU discovery programme) researcher mobility and internship programmes. As part of our research career development programme RUN-EU members will establish Gender Diversity Ambassadors to support, encourage and advocate for women in R&I and career advancement within the RUN-EU participant network, following commission recommendations on gender balance and equality. Furthermore, RUN-EU+ will introduce a research career evaluation system to reward researchers and research excellence at all career development stages. As part of our cloud of knowledge portal, RUN-EU members will also equip our students and researchers with a combination of pedagogical as well as research skills. The European Charter views teaching as an essential means for structuring and disseminating knowledge and as such is an invaluable option within our researchers' career paths.

14. RESEARCH FACILITIES

Following IPCA R&D strategic goals, it has already guaranteed funding to construct a dedicated research infrastructure. Barcelos Collaborative Research Innovation Center (B-CRIC) will be completed by 2025 and will offer ~6000 m2 dedicated to research, innovation and entrepreneurship. The construction will be started in May, 2022. It will combine in a unique space all IPCA R&D units, as well as, spin-offs and business incubators. B-CRIC aims to be a strategic scientific infrastructure of applied research located in Barcelos, which will guarantee direct translation of the scientific technology to society. It will offer a set of services to support the regional industries, such as a public FabLab and support offices, namely Intellectual Property and Technology Transfer (IPTT), and Internationalization and Project Support Offices. Moreover, to support research activities and events, it will include a dedicated auditorium for 500 persons.

Figure 4 – B-CRIC facilities.

Specifically, the 2Ai, with 1800 m2, will be composed of a large open space with 5 laboratories, fully equipped with state-of-the-art technologies, targeting our main application areas, namely: Laboratory 1 - Surgical Room of the Future; Laboratory 2 - Robotic Surgical Imagiology; Laboratory 3 - Human-Robot Collaboration; Laboratory 4 - Smart Manufacturing; and Laboratory 5 - Advanced Visualization and Interaction Experience. The 2Ai will also have a set of support facilities, namely a data acquisition room, multiple meetup spaces, a brainstorming lounge, and a large open space for meetings, designated Journal Club).

15. IMPACT ACTIONS TO THE SOCIETY

With the main objectives of bringing basic and secondary schools closer to sources of knowledge and technology (R&D Units), and contact with the scientific community, production of knowledge and innovation, 2Ai has promoted a set of activities aimed at basic and secondary schools to stimulate students to be interested in science and technology.

On November 11 and 25, 2021, 2Ai was visited by students from the Electronics and Mechatronics professional courses of Escola Profissional de Barcelos. The students had the opportunity to visit the 2Ai laboratories and establish contact with researchers. The 2Ai laboratories visit was marked by the enthusiasm and interest shown by the students.

On November 19, 2021, 2Ai received a visit of ERASMUS students and teachers from five European countries as part of the “Fiers d'être européens!” project promoted by Rosa Ramalho School, Barcelos. Visitors had the opportunity to participate in a workshop with the theme “Motion capture and animation technologies for video games”. The activity ended with a visit to 2Ai laboratories.

On November 25, 2021, students/researchers from the 2Ai and School of Technology of IPCA promoted two activities, with the themes "LITTLEBITS" and "COLLABORATIVE ROBOTS" at the EB 2,3 Gonçalo Nunes school, Barcelos, within the scope of the Science and Technology week developed by the School of Technology of IPCA.

Targeting specific society challenges, 2Ai also participated in the implementation of solutions to fight the COVID-19 pandemic, namely the development of an AI module to automatically identify COVID-19 in CT images. The proposed method was validated in an international challenge, being selected as one of the finalists.

16. OUTREACH ACTIVITIES

The program of outreach activities implemented by the 2Ai focuses on a strategy to promote scientific awareness in the surrounding community on: the importance of R&D on applied artificial intelligence in health, industry, environment and security impact areas.

For that, 2Ai members participated in external national events, namely the “Encontro com a Ciência e Tecnologia em Portugal - Lisboa 2021”, through the participation in the thematic sessions “Research, Pedagogical Innovation and International Cooperation Networks in Polytechnics” and “Health Sciences - Telemedicine, Computational Biology and Medical Applications”. Moreover, 2Ai members participated in specific events organized by the EuropeDirect Minho centered on the Artificial Intelligence topic.