



# **Internship Projects**

## **2023**

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## MRG: Biometrics for Smart human-Centred EmergiNg Technologies (BIO-SCENT)

Internship Title	<a href="#">Image Interpretation From Wearable Cameras</a>
Description of Internship	Wearable cameras are small and light devices which can be fastened at human body covering the point of view of the wearer. They provide the capability to seamlessly record visual data in a passive way, in a first-person perspective, while the wearer is performing her/his activities. Visual lifelogging is the seamless collection of images and/or videos using wearable cameras and involves the continuous recording of the daily life of the wearer for a long period of time. The new field of the computer vision which deals with the content analysis of data collected by wearable cameras, is called Egocentric Vision or First-person Vision. The analysis of such visual data can be successfully used to study everyday life and draw useful conclusions about human behavior, aiming to improve the quality of life.
Required Skills	<ol style="list-style-type: none"> <li>1. Basic knowledge in image processing or computer vision or deep learning</li> <li>2. Computer programming skills</li> </ol>
Level of required Skills	Good
Internship Objectives	<p>The aim of the project is to develop advanced technologies for visual lifelog image analysis. Visual lifelog image analysis is concerned with the analysis of first-person images captured by wearable cameras or smart phones. The project will involve work in collecting and labelling data for supervised learning frameworks and/or the development of deep learning methods for interpreting visual lifelog images and/or experimental evaluation. Image interpretation algorithms will involve image enhancement, object detection and action classification.</p> <p>The work may focus either on the existing active projects of “First-Person Image Analysis for Developing Pedestrian Assistive Technologies”, “Enhancing the experience of museum’s visitors with the aid of wearable cameras”, and “Action Recognition in Smart Spaces”, or focus on a novel application.</p>

Internship Title	<a href="#">Developing Interactive Applications for Enhancing Visitor Experience in Cultural Heritage Sites</a>
Description of Internship	The aim of the work is to develop interactive applications utilizing state of the art techniques in emerging technologies aiming to enhance the experience of visitors in Cultural Heritage Sites or other related sites such as museums and exhibitions. As part of this project interns will be expected to use techniques related to virtual/mixed reality, computer vision, and mobile applications.
Required Skills	<p>Interns working in this project should have technical and/or creating skills that include</p> <ol style="list-style-type: none"> <li>1. Computer Programming Skills</li> <li>2. Basic knowledge in image processing or computer vision</li> <li>3. Development of virtual/mixed reality applications</li> <li>4. Mobile application development</li> </ol>
Level of required Skills	Good
Internship Objectives	<p>The objectives of the Internship are:</p> <ol style="list-style-type: none"> <li>1) To review the literature in relation to the use of emerging technologies in Cultural heritage sites</li> <li>2) To design, implement and evaluate s novel interactive application for enhancing the experience of cultural heritage site/museum visitors.</li> </ol>

Internship Title	<a href="#">Image Analysis in Marine and Maritime domain using computer vision techniques</a>
Description of Internship	<p>Ocean imaging has become very popular nowadays, as an easy way to monitor the marine and maritime environment. Monitoring can be utilized for the protection of several threats that the Marine and Maritime industry faces or for the automation of everyday processes in the domains of border control, safety and security, fisheries control, customs, environment, defense, etc. The manual analysis of the large amounts of monitoring data is very time consuming and difficult task. Thus, the computer vision techniques have been extensively used to automate the process. Although computer vision has many advances the last years, the research for marine and maritime is at an early stage and several challenges remain open.</p>
Required Skills	1. Computer Programming Skills
Level of required Skills	Good
Internship Objectives	<p>Through the use of computer vision, the integrated ocean monitoring can be achieved offering ways to exchange and visualize information and data. Although some techniques for automated detection, identification, measurement, tracking, and counting objects (e.g. fishes, oil spills, etc.) in underwater or sea surface optical data streams have been proposed, very few automated systems are available which incorporate all appropriate techniques for highly successful and accurate results. The main objective of this project is to develop beyond the state-of-the-art technologies for analyzing ocean visual data. For this purpose, an extensively research review will be conducted to define the challenges of computer vision techniques in the domain, and then innovative techniques will be developed to tackle them which may include: pre-processing methods for enhancing the image quality, image segmentation to extract and locate the visual content, feature extraction and machine learning for modelling the object categories, and innovate image classification schemes using deep learning techniques.</p>

## MRG: Smart Networked Systems (SNS)

Internship Title	<b>Topology Control Algorithms for Wireless Sensor Networks and the Internet of Things</b>
Description of Internship	Wireless Sensor Networks are special types of networks with limited communication, processing and energy capabilities. This topic deals with the implementation of specific topology control algorithms. They mainly deal with network tree construction, maintenance and optimization. Many ideas are already defined, but additional development may be needed to match them to an overall concept. Students will have to get familiarized with the operating system (Contiki) and the accompanying sensor simulator (COOJA), which will not be difficult since they are both C/C++ based.
Internship Objectives	To create new algorithms for WSN and IoT topology control
Expected Deliverables	Final Report, Simulation Scripts

Internship Title	<b>Protocols for Mobile Sensor Networks</b>
Description of Internship	This topic deals with the implementation and evaluation of mobility management protocols for Wireless Sensor networks. Mobility is examined in the context of general 6LowPAN networks and specific performance-controlled implementation (GinMAC). The student involved will build a small testbed of TelosB or similar nodes and program them in Contiki. The Cooja simulator will also be used for proof of concept validation.
Required Skills	Basic knowledge of historical research (including oral history or art history)
Internship Objectives	To create new/test existing algorithms for WSN and IoT mobility
Expected Deliverables	Final Report, Simulation Scripts, Testbed

Internship Title	<b>Use of Mobile Nodes for Congestion Control and Fault Tolerance</b>
Description of Internship	This topic deals with the implementation of certain features and the evaluation of algorithms already developed at UCY, for the use of mobile nodes for fixing congestion problems or other faults in WSNs and IoT networks
Required Skills	Computer Networks, Network protocols, Basic Programming
Internship Objectives	To create new algorithms for use of Mobile Nodes for network recovery
Expected Deliverables	Final Report, Simulation Scripts

Internship Title	<b>Anomaly Detection Algorithms</b>
Description of Internship	Every sensor and embedded device is prone to error failure which can be caused by natural causes such as environmental effects, battery discharging or by malicious invasion to the network. A fault in a node can decrease network performance and/or in the worst case scenario, dissolution of the network. Diagnosing faults in the network at an early stage can decrease the possibilities of tear down the network. Fault diagnosis can help identify the nature of the error; whether the error is a result of malicious intervention or of natural causes. The goal of the current project is to create faults so that to train a diagnosis tool. The tool will evaluate a set of data that will be considered crucial to identify the presence of fault or malicious intervention in the network. Data gathered in a controlled environment will be profiled as normal behavior, that is, behavior with no faults present in the network. Data will also be taken in simulations where faults, or attacks are present. Both benign and malicious data will be used to establish boundaries that will identify the presence of malicious attack of failure. The recognition and classification of the activity will be based on one or more techniques from Statistical Analysis, Machine Learning and Computational Intelligence.
Required Skills	Computer Networks, Network protocols, Basic Programming, basic understanding of AI/ML
Internship Objectives	To create new intrusion detection techniques, or the extensive evaluation of existing techniques.
Expected Deliverables	Final Report, Simulation Scripts

Internship Title	<b>Internet of Things Intrusion Detection</b>
Description of Internship	Extension of the topic on anomaly detection by focusing more on the new types of topologies created in IoT settings. Implementation of monitoring at the gateway node and creation and evaluation of new types of attacks, related to the types of protocols most used in IoT (RPL, CoAP, MQTT etc).
Required Skills	Computer Networks, Network protocols, Basic Programming, basic understanding of AI/ML
Internship Objectives	To create new intrusion detection techniques, or the extensive evaluation of existing techniques.
Expected Deliverables	Final Report, Simulation Scripts

Internship Title	<b>Implementation of direct communication between smartphones</b>
Description of Internship	As part of ongoing work on Device-to-Device communication there is a need to implement and experiment with different types of technologies enabling direct communication. There are two modes of operation: interchanging files (ftp like) and sharing communication resources (one acts as a relay/router for the other). Work in this topics includes programming for Android phones (android studio or similar) to implement the two communication modes in WIFI-direct and LTE Direct.
Required Skills	Computer Networks, Network protocols, Basic Programming, Android programming
Internship Objectives	To implement a direct communication solutions between smartphones
Expected Deliverables	Final Report, Testbed



Internship Title	<b>Design and Development of the User Equipment based Virtual Base Station (UE-VBS)</b>
Description of Internship	<p>Year by year, new Smartphones are released that are more capable and more powerful than the generation preceding it. Due to their advanced hardware, increased processing power and storage space, vastly improved networking capabilities and networking speeds, current market-based UEs have reached a stage of becoming powerful enough to fulfill almost all of our computing and communication demands. The aim of the UE-VBS concept is to exploit these unutilized resources for augmenting and supporting the Cellular Infrastructure to tackle the ambitious goals set for emerging 5G/6G Networks. More specifically, through a simple mobile application software, the Mobile Users will have the opportunity to: i) enhance their Smartphones into User Equipment based Virtual Base Stations<sup>1</sup> (UE-VBSs); ii) embed them as an integral and compatible part of the Mobile Network Operators (MNOs) cellular infrastructure; and iii) get rewarded by offering networking services (i.e., deploy virtual small cells or relay traffic) for extending data rates, capacity and backhauling capabilities in a targeted and scalable manner, in areas where the Cellular Infrastructure is weak and demands in coverage, capacity and data rates are greater than it can provide.</p>
Required Skills	<p>Knowledge/Experience in the following aspects:</p> <ul style="list-style-type: none"> <li>• 5G Mobile Networks</li> <li>• State-of-the-art Mobile Network Architectures and 5G Technologies (i.e., SDN, NFV, D2D, SON, etc.);</li> <li>• 5G Network Equipment and Mobile/Portable Devices already in the market and their technical capabilities;</li> <li>• Android Programming</li> </ul>
Level of required Skills	
Internship Objectives	<ol style="list-style-type: none"> <li>1. Perform a comprehensive survey grounded on the latest 3GPP Technical Specification (TS) and Technical Reports (<a href="https://www.3gpp.org/">https://www.3gpp.org/</a>), so as to identify aspects of the market-based Mobile Devices that should be evolved for allowing them to be enhanced into UE-VBSs (i.e., able to serve as a Virtual Small Cell or a Virtual Relay Node).</li> <li>2. Provide the design (i.e., Software enhancements) that need to be made on the existing market-based Smartphones that will allow them to be enhanced into UE-VBs and operate in currently being deployed 5G Mobile Networks.</li> <li>3. Develop the UE-VBS application. For the scope of this project, the UE-VBS application will developed for Android 10 and above compatible Mobile Devices using the latest android studio and SDK tools. In addition, the GUIs of the UE-VBS app allowing the Mobile Users to interact and control their Smartphones, might needed to be developed.</li> </ol>

Internship Title	<b>Design of an Evolved Mobile Network Architecture incorporating the UE-VBS Layer in E-UTRAN</b>
Description of Internship	<p>Year by year, new Smartphones are released that are more capable and more powerful than the generation preceding it. Due to their advanced hardware, increased processing power and storage space, vastly improved networking capabilities and networking speeds, current market-based UEs have reached a stage of becoming powerful enough to fulfill almost all of our computing and communication demands. Capitalizing on the dense and ubiquitous distribution of the Mobile users (expected to reach a total of 5.8 billion unique mobile subscribers by 2025 ) in our physical world, the vision is to form, through their Mobile Devices (i.e., Smartphones, Tablets, etc.), a new highly flexible, manageable and cost-effective (in terms of CAPEX and OPEX) multi-vendor, multi-spectrum and multi-RAT virtual cellular infrastructure (we refer to this as UE-VBS layer), at the bottom tier of E-UTRAN. On this virtual UE-VBS layer, the MNOs would be able to control and exploit on-demand, either as Virtual Small Cells (VSCs) or Virtual Relay Nodes (VRNs), the UE-VBSs comprising it. Such virtual layer can provide to MNOs a distributed pool of capacity from a well-balanced combination of different spectrum and air interfaces able to: i) Extend capacity and data rates in a target and scalable manner to meet the dynamic and high-bandwidth requirements of 5G use cases; ii) Automate the</p>

<sup>1</sup> A Smartphone enhanced into a UE-VBS can serve as: i) a Virtual Small Cell (VSC) used for coverage/capacity/data rates expansion in areas where the infrastructure is weak; and/or ii) as a Virtual Relay Node (VRN) facilitating the effective and efficient flow of data within the Radio Access Part

	real-time organization, reconfiguration and optimization of their Cellular Infrastructure and Operation to deliver assured service quality across the entire cell (always adapted to the Radio Access Network demands, stresses or failures and driven always by the current location trends and preferences of the users) and flexible enough to achieve the Enhanced Mobile Broadband (eMBB) and massive capacity defining characteristics of 5G.
Required Skills	<p>Knowledge/Experience in the following aspects:</p> <ul style="list-style-type: none"> <li>• 5G Mobile Networks</li> <li>• State-of-the-art Mobile Network Architectures and 5G Technologies (i.e., SDN, NFV, D2D, SON, etc.);</li> <li>• 5G Network Equipment and Mobile/Portable Devices already in the market and their technical capabilities;</li> </ul>
Level of required Skills	
Internship Objectives	<ol style="list-style-type: none"> <li>1. Perform a comprehensive survey grounded on the latest 3GPP Technical Specification (TS) and Technical Reports (<a href="https://www.3gpp.org/">https://www.3gpp.org/</a>), so as to identify aspects of the Mobile Network Architecture that should be evolved to allow the UE-VBS Layer to be embedded as an integral and compatible part of E-UTRAN in currently being deployed 5G Mobile Networks</li> <li>2. Provide the design of the Evolved Mobile Network Architecture incorporating the UE-VBS Layer in E-UTRAN. With respect to the design of the overall architecture, the SDN and NFV technologies for 5G/6G, should be considered, as these technologies are expected to be a perfect match to the virtualised resource aspect of the UE-VBS Layer. The value of SDN, particularly in combination with NFV, is its ability to provide network virtualization, automation and create new services on top of virtualized resources offered by the UE-VBS layer. In this manner, a dynamic, highly manageable, and cost-effective architecture can be provided for 5G, making it ideal for the ever changing, dynamic, high-bandwidth nature of 5G use cases.</li> </ol>

## MRG: The Next Generation of Smart Cameras (DeepCamera)

Internship Title	Modular deep learning tool
Description of Internship	Developing a deep learning approach is tedious and requires a large amount of time. In this project you will build an innovative framework which will allow the development of complex deep-learning approaches in a graphical fashion and then translate them in the corresponding code representation.
Required Skills	Python, Deep-learning, deep-learning environments, JSON
Level of required Skills	Good level
Internship Objectives	The project aims are the following: <ol style="list-style-type: none"><li>1. Develop a graphical tool for developing deep-learning approaches (front-end).</li><li>2. Develop the back-end component.</li></ol>

Internship Title	DgiStreamer use cases development
Description of Internship	The DeepCamera group at CYENS has recently developed Dgistreamer, a tool to develop and easily deploy any pipeline ( <a href="https://dgistreamer.com">https://dgistreamer.com</a> ). This has previously been used in collaboration with the LEAR group at CYENS for the deployment of a computer vision pipeline detecting humans in an embedded system installed on a unitree A1 robot: <a href="https://www.youtube.com/watch?v=VwwVzQpdIcc">https://www.youtube.com/watch?v=VwwVzQpdIcc</a> . In this project, you will develop use cases using DgiStreamer and the corresponding documentation, video and report.
Required Skills	Computer programming skills
Level of required Skills	Good level
Internship Objectives	The project aims are the following: <ol style="list-style-type: none"><li>1. Learn GStreamer framework syntax.</li><li>2. Develop a GStreamer-based node to read all the robot sensors.</li></ol>

## MRG: Interactive Media and Education/Edutainment (EdMedia)

Internship Title	<b>UX/LX (learning experience) Design</b>
Description of Internship	We are looking for students interested to work on the design of educational platforms or/and technology-enhanced learning experiences. Check out <a href="http://edmedia.cyens.org.cy/">http://edmedia.cyens.org.cy/</a> and <a href="https://www.cyprusinteractionlab.com/">https://www.cyprusinteractionlab.com/</a> for some of our projects
Required Skills	<ul style="list-style-type: none"> <li>- EdTech background</li> <li>- Interest/experience in UX research</li> <li>- Interest/experience in Learning research</li> <li>- Good tech skills as user. Experience with emerging tech (e.g., VR, AR) is considered an advantage</li> </ul>
Level of required Skills	- Good
Internship Objectives	- Deliver education platform UX/LX design or technology-enhanced learning experiences

## MRG: Immersive Technologies for Intelligent and Creative Applications (ITICA)

Internship Title	<b>Creative Industries with Emerging Technologies for Virtual and Augmented Reality applications</b>
Description of Internship	We are looking for students interested to work with Augmented and Virtual reality technologies blended with elements from the cultural and creative industries. The work will focus on: a) developing modules such as facial/image/object recognition to be embedded on augmented reality glasses and b) on virtual reality integrated with haptic feedback to build applications and/or creative installations.
Required Skills	<ul style="list-style-type: none"> <li>• Bachelor or master's degree in one of the following areas or a related area: computer science, graphic design, digital arts, cognitive systems and/or Mathematics</li> <li>• Programming skills in C++ or C#, and familiarity with game engines such as Unity3D and Unreal Engine. Experience with VR development.</li> <li>• Ability to create 3D models to be used in VR applications. Proficiency in 3DS Max, Maya or other 3D modeling software and Photoshop. Knowledge and ability to implement the full game asset pipeline, with experience in Substance Design a plus.</li> </ul>
Level of required Skills	Good

## MRG: Learning Agents and Robots (LEAR)

Internship Title	<b>Fast Learning of Diverse Robotic Skills</b>
Description of Internship	<p>Quality diversity (QD) optimization [1] is an emerging field that has shown great promise in automatically producing a diversity of high-quality robotic skills. However, QD algorithms typically require millions of evaluations with a robotic simulator, often executed on CPU clusters for days, which limits their practicality. The recent introduction of simulators that can execute physics calculations directly on the GPU [3-6] opens up great potentials in accelerating QD by orders of magnitude. For instance, [6] reports the use of such a simulator for training a legged robot to walk in just 20 minutes on a single workstation.</p> <p>Project aims:</p> <ol style="list-style-type: none"> <li>1) Accelerate the wall-clock time of QD algorithms for teaching legged robots a diversity of skills by implementing: <ul style="list-style-type: none"> <li>- standard QD algorithms on Nvidia's IsaacGym simulator [3,6] OR</li> <li>- differentiable QD algorithms [2] on differentiable simulators [4,5]</li> </ul> </li> <li>2) Evaluate the resulting framework by comparing against the state-of-the-art.</li> </ol>
Required Skills	<p>Very good programming skills (C++ or Python).  Experience with robotic simulation or physics engines.  Interest in legged robots, reinforcement learning, or evolutionary computation.</p>
Reading	<p>[1] Chatzilygeroudis, K., Cully, A., Vassiliades, V., &amp; Mouret, J. B. (2021). Quality-Diversity Optimization: a novel branch of stochastic optimization. In <i>Black Box Optimization, Machine Learning, and No-Free Lunch Theorems</i> (pp. 109-135). Springer, Cham.</p> <p>[2] Fontaine, M. C., &amp; Nikolaidis, S. (2021). Differentiable Quality Diversity. To appear in <i>NeurIPS 2021</i>. Preprint: <a href="https://arxiv.org/abs/2106.03894">https://arxiv.org/abs/2106.03894</a></p> <p>[3] Makoviychuk, V., Wawrzyniak, L., Guo, Y., Lu, M., Storey, K., Macklin, M., ... &amp; State, G. (2021). Isaac Gym: High Performance GPU-Based Physics Simulation For Robot Learning. <i>arXiv preprint arXiv:2108.10470</i>.</p> <p>[4] Freeman, C. D., Frey, E., Raichuk, A., Girgin, S., Mordatch, I., &amp; Bachem, O. (2021). Brax-A Differentiable Physics Engine for Large Scale Rigid Body Simulation.</p> <p>[5] Heiden, E., Millard, D., Coumans, E., Sheng, Y., &amp; Sukhatme, G. S. (2020). NeuralSim: Augmenting differentiable simulators with neural networks. <i>arXiv preprint arXiv:2011.04217</i>.</p> <p>[6] Rudin, N., Hoeller, D., Reist, P., &amp; Hutter, M. (2021). Learning to Walk in Minutes Using Massively Parallel Deep Reinforcement Learning. <i>arXiv preprint arXiv:2109.11978</i>.</p>

Internship Title	<b>Unsupervised Robotic Skill Discovery using Quality-Diversity Optimization and Sequence Encoder-Decoder Models</b>
Description of Internship	<p>Quality diversity (QD) optimization [1] is an emerging field that has shown great promise in automatically producing a diversity of high-quality robotic skills. However, one of their limitations is the need to hard-code a low-dimensional skill descriptor which often requires domain knowledge and causes delays in experiments. A recent study [2] used simple dimensionality reduction techniques to automatically extract the skill descriptor from high-dimensional information. While promising, that study did not focus on the temporal nature of the data streams, suggesting that the use of recurrent neural networks [3] or more advanced models, such as Transformers [4], for encoding and decoding the data streams would offer greater benefits.</p> <p>Project aims:</p> <ul style="list-style-type: none"> <li>- Develop a QD optimization framework for the automatic discovery of robotic skills using sequence-to-sequence models [3] or Transformers [4].</li> <li>- Evaluate the framework using hand-crafted skill descriptors, and simple dimensionality reduction techniques (Principal Components Analysis, Autoencoders).</li> </ul>

Required Skills	Very good programming skills (C++ or Python). Knowledge of machine learning and deep learning (including frameworks such as Tensorflow or PyTorch). Interest in robot learning and evolutionary computation.
Reading	[1] Chatzilygeroudis, K., Cully, A., Vassiliades, V., & Mouret, J. B. (2021). Quality-Diversity Optimization: a novel branch of stochastic optimization. In Black Box Optimization, Machine Learning, and No-Free Lunch Theorems (pp. 109-135). Springer, Cham. [2] Grillotti, L., & Cully, A. (2021). Unsupervised Behaviour Discovery with Quality-Diversity Optimisation. arXiv preprint arXiv:2106.05648. [3] Sutskever, I., Vinyals, O., & Le, Q. V. (2014). Sequence to sequence learning with neural networks. In Advances in neural information processing systems (pp. 3104-3112). [4] Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. In Advances in neural information processing systems (pp. 5998-6008).

Internship Title	<b>Accelerated Quality Diversity Optimization using Improved Selection and Variation Operators</b>
Description of Internship	Traditionally, the focus of evolutionary algorithms is to optimize black-box functions and return a single, globally optimal solution. However, many real-world cases demand for not just a single solution, but rather a diverse collection of high-quality ones. Quality diversity (QD) optimization [1-3] is a framework for solving such problems. QD algorithms have been successfully applied in domains such as robotics (e.g., creating behavioral repertoires), engineering (e.g., generating diverse aerodynamic designs) and video games (e.g., procedural level generation). However, they typically require a large number of evaluations to optimize both the coverage and the quality of the collection. In order to accelerate QD optimization, recent works proposed improved selection [2] and variation [4-6] operators, yet no systematic study has been conducted about their potentially complementary benefits. In addition, promising heuristics originated in the multimodal optimization literature (e.g., see [7,9]), have not yet been thoroughly investigated in the context of QD optimization.  Project aims: - Develop a framework for experimentation with various selection and variation operators in QD algorithms (e.g., see [2] and [8]). - Investigate and analyze properties of the collections (over iterations) and the combination of various operators in terms of QD-related metrics (e.g., coverage, mean archive fitness, max archive fitness, QD-score, hypervolume). - Develop and evaluate novel heuristics and operators that aim to improve QD optimization. - The focus should be on simplicity (e.g., see [4]). In case a learning model is employed, its complexity should be kept at a minimum.
Required Skills	Very good programming skills (C++ or Python). Knowledge of evolutionary computation. Interest in machine learning.
Reading	[1] Chatzilygeroudis, K., Cully, A., Vassiliades, V., & Mouret, J. B. (2021). Quality-Diversity Optimization: a novel branch of stochastic optimization. In Black Box Optimization, Machine Learning, and No-Free Lunch Theorems (pp. 109-135). Springer, Cham. [2] Cully, A., & Demiris, Y. (2017). Quality and diversity optimization: A unifying modular framework. IEEE Transactions on Evolutionary Computation, 22(2), 245-259. [3] Vassiliades, V., Chatzilygeroudis, K., & Mouret, J. B. (2017). Using centroidal Voronoi tessellations to scale up the multidimensional archive of phenotypic elites algorithm. IEEE Transactions on Evolutionary Computation, 22(4), 623-630. [4] Vassiliades, V., & Mouret, J. B. (2018). Discovering the elite hypervolume by leveraging interspecies correlation. In Proceedings of the Genetic and Evolutionary Computation Conference (pp. 149-156). [5] Fontaine, M. C., Togelius, J., Nikolaidis, S., & Hoover, A. K. (2020). Covariance matrix adaptation for the rapid illumination of behavior space. In Proceedings of the 2020 genetic and evolutionary computation conference (pp. 94-102). [6] Choi, T. J., & Togelius, J. (2021). Self-referential quality diversity through differential MAP-Elites. In Proceedings of the Genetic and Evolutionary Computation Conference (pp. 502-509).

	<p>[7] Preuss, M. (2010). Niching the CMA-ES via nearest-better clustering. In Proceedings of the 12th annual conference companion on Genetic and evolutionary computation (pp. 1711-1718).</p> <p>[8] <a href="https://pypi.org/project/qdpy/">https://pypi.org/project/qdpy/</a></p> <p>[9] Harik, G. R. (1995). Finding Multimodal Solutions Using Restricted Tournament Selection. In ICGA (pp. 24-31).</p>
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Internship Title	<b>Noisy Quality Diversity Optimization in Unbounded Domains</b>
Description of Internship	<p>Quality Diversity optimization algorithms [1] are capable of efficiently generating large collections of highly diverse and accurate solutions. MAP-Elites [2,3] is a popular and successful algorithm among this class. MAP-Elites assumes that diversity is maintained in a low-dimensional space, called the “behavior space”, where the bounds of each dimension are known. This assumption enables the pre-tessellation of the behavior space into a number of bins which will be populated with the locally best solutions after the end of the optimization process. Approaches that either do not use bins [4] or adapt the tessellation based on data [5] can be used when this assumption does not hold. A second but important assumption shared by most QD algorithms is that each solution evaluation is deterministic, i.e., there is no uncertainty about the fitness of the solutions, nor their behavior descriptors (i.e., their coordinates in behavior space). This assumption is unrealistic, thus, mitigating it would allow QD algorithms to have a broader impact. A recent extension of MAP-Elites [6], i.e., a “binning approach”, showed promising results, however, it is still an open problem how this can be accomplished efficiently in potentially high-dimensional behavior spaces where the bounds of each dimension are not known a priori.</p> <p>Project aims:</p> <ul style="list-style-type: none"> <li>- Develop new QD optimization algorithms robust to noise in a sample efficient manner, which do not require knowledge of the bounds of the behavior space.</li> <li>- Evaluate the algorithms by conducting experiments in various settings, against known algorithms, and analyse the results.</li> </ul>
Required Skills	<p>Very good programming skills (C++ or Python).</p> <p>Knowledge of evolutionary computation.</p> <p>Interest in machine learning or robot learning.</p>
Reading	<p>[1] Chatzilygeroudis, K., Cully, A., Vassiliades, V., &amp; Mouret, J. B. (2021). Quality-Diversity Optimization: a novel branch of stochastic optimization. In Black Box Optimization, Machine Learning, and No-Free Lunch Theorems (pp. 109-135). Springer, Cham.</p> <p>[2] Mouret, J. B., &amp; Clune, J. (2015). Illuminating search spaces by mapping elites. arXiv preprint arXiv:1504.04909.</p> <p>[3] Vassiliades, V., Chatzilygeroudis, K., &amp; Mouret, J. B. (2017). Using centroidal Voronoi tessellations to scale up the multidimensional archive of phenotypic elites algorithm. IEEE Transactions on Evolutionary Computation, 22(4), 623-630.</p> <p>[4] Lehman, J., &amp; Stanley, K. O. (2011). Evolving a diversity of virtual creatures through novelty search and local competition. In Proceedings of the 13th annual conference on Genetic and evolutionary computation (pp. 211-218).</p> <p>[5] Vassiliades, V., Chatzilygeroudis, K., &amp; Mouret, J. B. (2017). A comparison of illumination algorithms in unbounded spaces. In Proceedings of the Genetic and Evolutionary Computation Conference Companion (pp. 1578-1581).</p> <p>[6] Flageat, M., &amp; Cully, A. (2020). Fast and stable MAP-Elites in noisy domains using deep grids. In Artificial Life Conference Proceedings (pp. 273-282). One Rogers Street, Cambridge, MA 02142-1209 USA journals-info@mit.edu: MIT Press.</p>

Internship Title	<b>Deep Reinforcement Learning for Advanced Quadrupedal Locomotion from Vision</b>
Description of Internship	<p>Deep reinforcement learning has demonstrated great potential for learning robust quadrupedal robotic locomotion controllers [1,2]. These approaches typically rely on simulation, where privileged (ground truth) information (e.g., local terrain profile, friction coefficients etc.) is leveraged to train adaptive policies that do not use this information. The resulting controllers are then transferred on real robots making them capable of effectively handling certain real world environments. However, such controllers are “blind” - they do not use any</p>

	<p>information from the robot's camera. This disadvantage would make them fail in settings that require careful placement of their feet [3], or even simple obstacle avoidance. Enhancing simulation with such information [4-7] would make quadrupedal robots capable of autonomously handling an even greater diversity of environments, opening up new avenues for potential application. A recent impressive result along these research lines uses simulation to teach real autonomous drones to fly at high speeds (40km/h) in challenging environments (such as dense forests) without any crash [8].</p> <p>Project aims:</p> <ul style="list-style-type: none"> <li>- Develop challenging simulated environments for training quadruped robots using camera depth information, in addition to other sensors.</li> <li>- Implement deep RL algorithms and conduct experiments for robot training.</li> <li>- Evaluate the ability of the simulated robots to use appropriate gaits in any given situation.</li> </ul>
Required Skills	<p>Very good programming skills (C++ or Python).  Experience with robotic simulation.  Knowledge of machine learning (including deep learning and reinforcement learning) and computer vision.  Interest in legged robots.</p>
Reading	<p>[1] Lee, J., Hwangbo, J., Wellhausen, L., Koltun, V., &amp; Hutter, M. (2020). Learning quadrupedal locomotion over challenging terrain. <i>Science robotics</i>, 5(47).</p> <p>[2] Kumar, A., Fu, Z., Pathak, D., &amp; Malik, J. (2021). Rma: Rapid motor adaptation for legged robots. <i>arXiv preprint arXiv:2107.04034</i>.</p> <p>[3] Tsounis, V., Alge, M., Lee, J., Farshidian, F., &amp; Hutter, M. (2020). Deepgait: Planning and control of quadrupedal gaits using deep reinforcement learning. <i>IEEE Robotics and Automation Letters</i>, 5(2), 3699-3706.</p> <p>[4] Choromanski, K., Jain, D., Parker-Holder, J., Song, X., Likhoshesterov, V., Santara, A., ... &amp; Weller, A. (2021). Unlocking Pixels for Reinforcement Learning via Implicit Attention. <i>arXiv preprint arXiv:2102.04353</i>.</p> <p>[5] Shi, H., Zhou, B., Zeng, H., Wang, F., Dong, Y., Li, J., ... &amp; Meng, M. Q. H. (2021). Reinforcement Learning with Evolutionary Trajectory Generator: A General Approach for Quadrupedal Locomotion. <i>arXiv preprint arXiv:2109.06409</i>.</p> <p>[6] Imai, C. S., Zhang, M., Zhang, Y., Kierebinski, M., Yang, R., Qin, Y., &amp; Wang, X. (2021). Vision-Guided Quadrupedal Locomotion in the Wild with Multi-Modal Delay Randomization. <i>arXiv preprint arXiv:2109.14549</i>.</p> <p>[7] Sorokin, M., Tan, J., Liu, C. K., &amp; Ha, S. (2021). Learning to Navigate Sidewalks in Outdoor Environments. <i>arXiv preprint arXiv:2109.05603</i>.</p> <p>[8] Loquercio, A., Kaufmann, E., Ranftl, R., Müller, M., Koltun, V., &amp; Scaramuzza, D. (2021). Learning high-speed flight in the wild. <i>Science Robotics</i>, 6(59), eabg5810.</p>

Internship Title	<b>Continual Unsupervised Learning on Edge Devices</b>
Description of Internship	<p>Deploying sophisticated machine learning models on edge devices (e.g., smart phones) is starting to become mainstream through frameworks such as TensorFlow Lite. Yet, the ability to continually adapt the model after deployment on-device without making it forget its previous knowledge is still a challenge. Doing so would enable to go beyond transfer learning scenarios (which simply fine-tune a model to the recent data), and build personalized systems that obey privacy, data and network limitations. This kind of personalization opens up the door to many innovations: from smart camera traps that monitor biodiversity in forests as a means to understand and mitigate climate change, to building the next generation of robotic systems that become more adaptive and accurate the longer they look at a video [5]. Recent research has demonstrated the ability to continually learn on smart phones in the supervised learning setting [1,2] where class labels are available. The more challenging continual unsupervised learning [3,4] setting on edge devices is still an open problem.</p> <p>Project aims:</p> <ul style="list-style-type: none"> <li>- Investigate continual unsupervised learning algorithms from visual data, as well as their proper evaluation metrics and protocols.</li> </ul>



	<ul style="list-style-type: none"> <li>- Develop a ML system that can be deployed and trained on a smart phone.</li> <li>- Conduct experiments that demonstrate the superior abilities of the system compared to traditional approaches in terms of the chosen evaluation protocol.</li> </ul>
Required Skills	<p>Very good programming skills (Python and mobile app development).  Experience in computer vision or machine learning (including deep learning).</p>
Reading	<p>[1] Demosthenous, G., &amp; Vassiliades, V. (2021). Continual Learning on the Edge with TensorFlow Lite. arXiv preprint arXiv:2105.01946.  [2] Pellegrini, L., Lomonaco, V., Graffieti, G., &amp; Maltoni, D. (2021). Continual Learning at the Edge: Real-Time Training on Smartphone Devices. arXiv preprint arXiv:2105.13127.  [3] Smith, J., Taylor, C., Baer, S., &amp; Dovrolis, C. (2019). Unsupervised progressive learning and the stam architecture. arXiv preprint arXiv:1904.02021.  [4] Rao, D., Visin, F., Rusu, A. A., Teh, Y. W., Pascanu, R., &amp; Hadsell, R. (2019). Continual unsupervised representation learning. arXiv preprint arXiv:1910.14481.  [5] Pirk, S., Khansari, M., Bai, Y., Lynch, C., &amp; Sermanet, P. (2019). Online object representations with contrastive learning. arXiv preprint arXiv:1906.04312.</p>

Internship Title	<b>Data-driven hierarchical reinforcement learning</b>
Description of Internship	<p>The availability of huge datasets has enabled the success of deep neural networks trained with supervised learning in problems spanning vision, speech and natural language processing. Reinforcement learning (RL), although it has seen a number of impressive applications (e.g., in games, animation and certain robotic tasks), has yet to be as successful and widespread as supervised learning. RL algorithms that effectively use offline data could enable the creation of better decision making systems in many domains, from autonomous robots to healthcare (e.g., see [3]). Moreover, identifying the hierarchical task decomposition from such data (e.g., see [1,2]) would offer better model interpretability, as well as more efficient learning and planning in an online setting.</p> <p>Project aims:</p> <ul style="list-style-type: none"> <li>- Investigate algorithms for extracting hierarchical policies from demonstrations in hierarchical tasks in game environments (such as [4]).</li> <li>- Evaluate the adaptation time of the extracted policies in unseen tasks that share the same hierarchical structure and against flat policies trained through imitation learning.</li> </ul>
Required Skills	<p>Very good programming skills (C++ or Python).  Experience with reinforcement learning.  Interest in deep learning and games.</p>
Reading	<p>[1] Hengst, B. (2012). Hierarchical approaches. In Reinforcement learning (pp. 293-323). Springer, Berlin, Heidelberg.  [2] Pateria, S., Subagdja, B., Tan, A. H., &amp; Quek, C. (2021). Hierarchical Reinforcement Learning: A Comprehensive Survey. ACM Computing Surveys (CSUR), 54(5), 1-35.  [3] Levine, S., Kumar, A., Tucker, G., &amp; Fu, J. (2020). Offline reinforcement learning: Tutorial, review, and perspectives on open problems. arXiv preprint arXiv:2005.01643.  [4] <a href="https://minerl.io/">https://minerl.io/</a></p>

Internship Title	Projects related to switch-neuron networks
Description of Internship	<p>Adaptation to changing environments is a hallmark of intelligence. Creating software agents capable of efficiently adapting their behavior to a variety of unpredictable environmental changes presents a challenge with modern artificial neural networks (ANNs). In this project, we will investigate how to tackle this challenge and create adaptive ANNs using “switch neurons” [1]. Switch neurons were proposed as a mechanism that enables flexible and adaptive behavior in ANNs through gating the flow of information. These models have shown to produce optimal exploration strategies in certain simple tasks, however, their full potential currently remains unexplored. We will be looking into projects related to 1) learning such ANN architectures through neuroevolution / neural architecture search; 2) extending such neurons to i) handle noisy signals, ii) become more adaptive; 3) using them in more complex environments; 4) training them using gradient-descent; 5) comparing them with other adaptive ANNs, such as Long Short-Term Memory [2] networks.</p>
Required Skills	<p>Very good programming skills (C++ or Python).  Knowledge of machine learning, neural and evolutionary computation will be considered an advantage.</p>
Reading	<p>[1] Vassiliades, V. &amp; Christodoulou, C. (2016). Behavioral Plasticity Through the Modulation of Switch Neurons. <i>Neural Networks</i>, 74: 35-51.  [2] Hochreiter, S., &amp; Schmidhuber, J. (1997). Long short-term memory. <i>Neural Computation</i>, 9(8), 1735-1780.</p>

## MRG: Socially-Competent Robotic and Agent Technologies (SCRAT)

Internship Title	<b>Data Analysis and Visualization for Transparent User Profiling</b>
Description of Internship	When a user provides consent for some of their personal data to be used towards creating their profile and customizing their experience, a natural question arises on whether the user is really informed of what data is being explicitly gathered and what inferences can be drawn from that data. If, for example, a user has chosen to share their geo-location with their smartphone, but has declined to share other demographic information, is the user aware of what stream of data is being gathered by their smartphone, and that this stream of data might reveal indirectly their gender, age, or marital status? How can we most transparently present to the user what data is being gathered, and what inferences can be drawn from that data. Depending on the internship type, the project can be adapted towards the visualization of the gathered data, towards the formal analysis of the inferences that can be drawn, or towards other aspects of the problem that can be discussed and identified with the intern.
Required Skills	data visualization OR formal analysis OR data analytics OR data modeling
Internship Objectives	The main objective of the internship is to provide an answer to the following question: How can we most transparently present to the user what data is being gathered, and what inferences can be drawn from that data. Depending on the background of the intern, the project can be adapted towards the visualization of the gathered data, towards the formal analysis of the inferences that can be drawn, or towards other aspects of the problem that can be discussed and identified with the intern.

Internship Title	<b>Natural Language Interaction for Machine Coaching</b>
Description of Internship	When a human interacts with their machine assistant, the scope and language of their interaction is typically fixed by the developers of the assistant. Even in those cases where the assistant is capable of adapting to the human, the feedback that the human provides to facilitate this process is typically very restricted, and comes in the form of categorizing objects into classes (in support of supervised learning) or reacting to the execution of policies (in support of reinforcement learning). Yet, in real life, the adaptation of a human assistant comes through a much richer form of interaction, where both the assistant and their counterpart engage in a natural language dialogue, with each interlocutor explaining why they chose to take an action and/or why they consider an action to be (in)appropriate. This process of coaching, rather than simple supervision, allows for the much more efficient and robust transfer of knowledge to the assistant. This project seeks to investigate how this process of coaching can be used when the assistant is a machine (see <a href="https://www.researchgate.net/publication/334989337_Machine_Coaching">https://www.researchgate.net/publication/334989337_Machine_Coaching</a> ), focusing on how the machine will generate natural language explanations for its internal symbolically-represented knowledge and inferences, and how the natural language explanations received by the human counterpart will be turned into this internal representation. Depending on the internship type, the project can be adapted towards the natural language processing or generation part, towards the formal analysis of the coaching process, or towards the empirical investigation of the effectiveness of a natural language interaction for machine coaching.
Required Skills	natural language processing OR natural language generation OR formal analysis OR empirical cognitive psychology
Internship Objectives	The main objective of the internship is to investigate how the process of coaching can be used when the assistant is a machine, focusing on how the machine will generate natural language explanations for its internal symbolically-represented knowledge and inferences, and how the natural language explanations received by the human counterpart will be turned into this internal representation. Depending on the background of the intern, the project can be adapted towards the natural language processing or generation part, towards the formal analysis of the coaching process, or towards the empirical investigation of the effectiveness of a natural language interaction for machine coaching.

Internship Title	<b>Reconciling “Data for Learning” with “Data for Arguing”</b>
Description of Internship	The data-driven view of Artificial Intelligence that is currently at the focus of research and industrial attention can be thought to treat a dataset through a collaborative prism, as a collection whose members have certain commonalities; one wishes to identify these commonalities by embracing the statistics of the collection over the views supported by any single member. Case-based reasoning, on the other hand, treats a dataset through a combative prism, as a loose grouping of individuals that support divergent views; one wishes to resolve the tension between these divergent views by identifying which individual makes a stronger case over the other members of the collection. The project seeks to reconcile these two views of data, by bringing together techniques from machine learning and formal argumentation. Depending on the internship type, the project can be adapted towards the development and analysis of a formal framework for this reconciliation, or towards the design and empirical evaluation of simple heuristics that acknowledge both the statistical and argumentative nature of data.
Required Skills	statistical analysis OR formal argumentation OR theoretical machine learning OR empirical cognitive psychology
Internship Objectives	The main objective of the internship is to reconcile the data-driven view and the case-based view of AI, by bringing together techniques from machine learning and formal argumentation. Depending on the background of the intern, the project can be adapted towards the development and analysis of a formal framework for this reconciliation, or towards the design and empirical evaluation of simple heuristics that acknowledge both the statistical and argumentative nature of data.

Internship Title	<b>Teaching Computation through the Movement of Social Insects</b>
Description of Internship	Insects like ants and bees are known to exhibit complex social behavior, not least of which in the way that they move, and this despite their limited and local sensing and decision-making capabilities. Research has shown, in fact, that under appropriate environmental conditions, the behavior of social insects can simulate arbitrary computations (see <a href="https://www.researchgate.net/publication/268590027_An_Ant-Based_Computer_Simulator">https://www.researchgate.net/publication/268590027_An_Ant-Based_Computer_Simulator</a> ). The aim of this project is to develop a visual simulator of the movement of social insects, to be used as an educational tool for introducing elementary-school students to the basic notions of computation. Depending on the internship type, the project can be adapted towards the development of the visual and user-experience parts of the simulator, or towards the implementation of a scalable simulation engine that supports the asynchronous movement of thousands of insects.
Required Skills	visual simulation OR user experience OR parallel programming
Internship Objectives	The main objective of the internship is to develop a visual simulator of the movement of social insects, to be used as an educational tool for introducing elementary-school students to the basic notions of computation. Depending on the background of the intern, the project can be adapted towards the development of the visual and user-experience parts of the simulator, or towards the implementation of a scalable simulation engine that supports the asynchronous movement of thousands of insects.

Internship Title	<b>Predictive Visual Completion of Simple Sketched Figures</b>
Description of Internship	Deep neural-based architectures have emerged in the last decade as a powerful general-purpose substrate for learning directly from raw data, and have been used, in particular, for the predictive completion of images and text. It remains an interesting prospect whether shallower architectures, which presumably require considerably less training data, might be sufficient for the predictive completion of

	simple sketched figures. The project aims to develop an application for a touch-based device that allows a user to hand-draw simple figures, while the application attempts in parallel to anticipate and visualize the remainder of the figure. Depending on the internship type, the project can be adapted towards investigating theoretically whether simple local learning mechanisms and relatively few training examples suffice for the particular task, or towards the actual development of the application and the empirical evaluation of the efficacy of heuristic learning techniques.
Required Skills	zero-shot learning OR local-to-global behavior OR smart-device programming OR empirical evaluation
Internship Objectives	The main objective of the internship is to develop an application for a touch-based device that allows a user to hand-draw simple figures, while the application attempts in parallel to anticipate and visualize the remainder of the figure. Depending on the background of the intern, the project can be adapted towards investigating theoretically whether simple local learning mechanisms and relatively few training examples suffice for the particular task, or towards the actual development of the application and the empirical evaluation of the efficacy of heuristic learning techniques.

Internship Title	<a href="#">Teaching Machines to Extract World Knowledge from Text</a>
Description of Internship	A point made ad nauseam in the literature is that general-purpose AI systems will need to be able to utilize some form of world knowledge to comprehend the situations that they face. While raw text has been proposed as a potentially-useful source of such knowledge (see <a href="https://www.researchgate.net/publication/215991030_A_First_Experimental_Demonstration_of_Massive_Knowledge_Infusion">https://www.researchgate.net/publication/215991030_A_First_Experimental_Demonstration_of_Massive_Knowledge_Infusion</a> ), the completely autonomous choice of learning material risks derailing the learning process towards sifting through the massive haystack of irrelevant text found, for example, on the Web, while searching for the proverbial needle of useful training material. The project seeks to develop curriculum learning techniques for directing the learning process. Depending on the internship type, the project can be adapted towards empirically demonstrating the effectiveness of curriculum learning over completely autonomous learning, towards the investigation of whether knowledge for a particular domain of interest is, even in principle, learnable from Web text, or towards the identification of appropriate natural language processing techniques for parsing text and extracting knowledge.
Required Skills	curriculum learning OR natural language processing OR text mining OR knowledge extraction
Internship Objectives	The main objective of the internship is to The project seeks to develop curriculum learning techniques for directing the learning process. Depending on the background of the intern, the project can be adapted towards empirically demonstrating the effectiveness of curriculum learning over completely autonomous learning, towards the investigation of whether knowledge for a particular domain of interest is, even in principle, learnable from Web text, or towards the identification of appropriate natural language processing techniques for parsing text and extracting knowledge.

Internship Title	<a href="#">Eliciting and Visualizing Actionable User Preferences</a>
Description of Internship	A key feature of personalization is the elicitation and utilization of a user's preferences to anticipate their future choices. Any form of prompting during the elicitation process, however, might critically affect what information is divulged by the user, suggesting that a passive learning process might be appropriate. On the other hand, theoretical analysis (see <a href="https://www.researchgate.net/publication/316279661_Introspective_Forecasting">https://www.researchgate.net/publication/316279661_Introspective_Forecasting</a> ) suggests that passive learning is inappropriate if one wishes to acquire actionable knowledge. The project seeks to reconcile these views by exploring the use of preference elicitation in a real-world setting. Depending on the internship type, the project can be adapted towards identifying a domain in which preference elicitation

	can be useful and empirically exploring the effectiveness of different learning strategies, or towards the development and analysis of formal elicitation processes that exhibit certain desirable properties.
Required Skills	empirical evaluation OR software development OR formal analysis OR theoretical machine learning
Internship Objectives	The main objective of the internship is to reconcile the two seemingly-conflicting requirements for the process of personalization by exploring the use of preference elicitation in a real-world setting. Depending on the background of the intern, the project can be adapted towards identifying a domain in which preference elicitation can be useful and empirically exploring the effectiveness of different learning strategies, or towards the development and analysis of formal elicitation processes that exhibit certain desirable properties.

Internship Title	<a href="#">Crowdsourced Event Reporting in a Smart City Setting</a>
Description of Internship	The “wisdom of the crowd” has been used extensively to elicit reliable information from a collection of potentially unreliable sources, typically relying on the cognitive abilities of humans to compute an answer, recall information, or express an opinion. In the era of the Internet of Things, and with the widespread use of mobile smart devices (such as smartphones, smartwatches, etc.), humans in a crowdsourcing context can also be viewed as sensing devices with an admittedly powerful edge-computing ability to recognize events or situations. This project aims to develop a crowdsourcing application that runs on mobile smart devices and that offers a one-button solution to reporting events in a smart city setting, along with a back-end server application to collect, evaluate, aggregate, and visualize the reported events. Depending on the internship type, the project can be adapted towards the development of the applications and their empirical evaluation, or towards the design and analysis of appropriate incentive schemes and aggregation methods to guarantee the quality of the reporting.
Required Skills	smart-device programming OR empirical evaluation OR incentive design / game theory OR data aggregation
Internship Objectives	The main objective of the internship is to develop a crowdsourcing application that runs on mobile smart devices and that offers a one-button solution to reporting events in a smart city setting, along with a back-end server application to collect, evaluate, aggregate, and visualize the reported events. Depending on the background of the intern, the project can be adapted towards the development of the applications and their empirical evaluation, or towards the design and analysis of appropriate incentive schemes and aggregation methods to guarantee the quality of the reporting.

MRG: Smart, Ubiquitous, and Participatory Technologies for Healthcare Innovation

Internship Title	Evidence-based digital intervention targeting cancer patients’ health-related quality of life
Description of Internship	<p>The project aims to test an evidence-based digital intervention targeting cancer patients’ health-related quality of life. More specifically, the system consists of a smartphone app that includes two basic features: (a) <b>Data collection</b> of patient-reported outcome measures such as pain, fatigue and general wellbeing using the Ecological Momentary Assessment (EMA) approach where data are collected using prompts in patients’ real life and in real time; (b) <b>Symptom management</b> using an Ecologically Momentary Intervention (EMI) where patients use a Virtual Reality (VR) system to alleviate their symptoms of pain for example.</p> <p>Data collection is ongoing in participating hospitals such as the American Medical Centre in Nicosia. More health centres treating cancer patients may join the consortium.</p>
Required Skills	<ul style="list-style-type: none"> <li>• Bachelor or master’s degree in one of the following areas or a related area: psychology, medicine, nursing, medical sociology, or other health-related sciences</li> <li>• Some experience with working with patients, collecting field data and adhering to ethical guidelines</li> <li>• Positive attitude and ability to work with a multi-disciplinary team</li> <li>• Flexibility in working hours to meet the hospitals’ needs</li> </ul>
Level of required Skills	Bachelor’s or master’s degree
Internship Objectives	<p>The successful candidate(s) will be: (a) working closely with hospital partners to schedule appointments for data collection; (b) consent patients and help hospital staff with data collection; (c) inputting data; (d) monitor the use of the app and the VR wearables in collaboration with the research team</p> <p>The project is run in collaboration with the Cyprus University of Technology’s Department of Nursing.</p>

Internship Title	<b>Dementia Project</b>
Description of Internship	<p>People with dementia residing in long-term care are usually facing numerous motor and cognitive impairments and go through therapeutic physical and cognitive training. In recent years, there have been a growing research interests towards designing non-pharmacological interventions aiming to improve the quality of life for people with dementia within long-term care. We are currently exploring the use of Virtual Reality for patients with mild, moderate, and severe dementia in collaboration with the Archangelos Michael Elderly People NursingHome / Rehabilitation Centre for Patients with Alzheimer. We are exploring the appeal of using VR for people with dementia, and the observed impact such interaction has on their physical and cognitive trainings. Moreover, we are investigating the design opportunities, pitfalls, and recommendations for future deployment in healthcare services. Using a user-centred design approach, we are carrying out multisite trials to evaluate the effectiveness of the virtual reality system that will be developed and to improve its usability.</p>
Required Skills	<ul style="list-style-type: none"> <li>• Bachelor or master's degree in one of the following areas or a related area: computer science, graphic design, digital arts, cognitive systems.</li> <li>• Programming skills in C++ or C#, and familiarity with game engines such as Unity3D and Unreal Engine. Experience with VR development.</li> <li>• Ability to create 3D models to be used in VR applications. Proficiency in 3DS Max, Maya or other 3D modeling software and Photoshop. Knowledge and ability to implement the full game asset pipeline, with experience in Substance Design a plus.</li> <li>• Bio-signals Analysis skills, preferably in Electrocardiography (ECG), Photoplethysmogram (PPG), Electromyography (EMG), Electrodermal Activity (EDA).</li> </ul>
Internship Objectives	<p>The successful candidate will be: (1) designing and developing Virtual Reality environments; (2) programming tracking devices (such as Arduinos), and or bio-signal devices (such as myo armband) suitable to the needs of a people with dementia and cancer patients; and (3) analysing bio-signals.</p>

Internship Title	<b>Cancer Project</b>
Description of Internship	<p>Cancer project proposes to design a low-cost mobile VR system to complement patients' physiotherapy and psychotherapy. The system will be able to accurately monitor the physical training performed by the patient on a daily basis. In addition, the system will assess in real-time the patient's performance and will provide guidance to improve the training tasks accuracy. The system will also serve as a virtual platform to facilitate remote psychotherapy for the cancer patients and their psychotherapists. To do so, it leverages on a few state-of-the-art technologies: (1) <i>Virtual Reality</i>, through the use of low-cost Head-Mounted Display (HMD) systems, which will surround the user's vision completely. The VR-HMDs include head-tracking machinery to track the motion of the user's head and present a 360° Virtual Environment; and (2) <i>Interactivity Devices</i>, to enhance the user's engagement into the Virtual Environment and to monitor and correct the user's movement. These interactive devices will include Arduinos, which will facilitate more natural movements and navigations in the Virtual Environment.</p>



Required Skills	<ul style="list-style-type: none"> <li>• Bachelor or master's degree in one of the following areas or a related area: computer science, graphic design, digital arts, cognitive systems.</li> <li>• Programming skills in C++ or C#, and familiarity with game engines such as Unity3D and Unreal Engine. Experience with VR development.</li> <li>• Ability to create 3D models to be used in VR applications. Proficiency in 3DS Max, Maya or other 3D modeling software and Photoshop. Knowledge and ability to implement the full game asset pipeline, with experience in Substance Design a plus.</li> <li>• Bio-signals Analysis skills, preferably in Electrocardiography (ECG), Photoplethysmogram (PPG), Electromyography (EMG), Electrodermal Activity (EDA).</li> </ul>
Internship Objectives	<p>The successful candidate will be: (1) designing and developing Virtual Reality environments; (2) programming tracking devices (such as Arduinos), and or bio-signal devices (such as myo armband) suitable to the needs of a people with dementia and cancer patients; and (3) analysing bio-signals.</p>

Internship Title	STTech Project
Description of Internship	Safe Transfer Techniques (STTech) is an Erasmus+ funded project. The overall goal of the project is to reduce transfer related works accidents as well as attrition among caregivers of Today's Health Care Sector. The outputs of the project will be: Guidelines and toolkit Digital tools - e-learning and Virtual Reality Interactive Handbook. These will be free and accessible tools at the project's website, as we develop them.
Required Skills	<ul style="list-style-type: none"> <li>• Bachelor or master's degree in one of the following areas or a related area: computer science, graphic design, digital arts, cognitive systems.</li> <li>• Programming skills in C++ or C#, and familiarity with game engines such as Unity3D and Unreal Engine. Experience with VR development.</li> <li>• Ability to create 3D models to be used in VR applications. Proficiency in 3DS Max, Maya or other 3D modeling software and Photoshop. Knowledge and ability to implement the full game asset pipeline, with experience in Substance Design a plus.</li> <li>• Bio-signals Analysis skills, preferably in Electrocardiography (ECG), Photoplethysmogram (PPG), Electromyography (EMG), Electrodermal Activity (EDA).</li> </ul>

Internship Title	CoViRR Project
Description of Internship	<p>CoViRR Project aims to co-create virtual reality reusable e-resources promoting innovative practices in the digital era, by supporting current curricula and fostering open education in the healthcare sector</p> <p>Simulation based training is identified as a valid teaching/learning strategy. Yet, little evidence exists for the design and use of virtual reality reusable e-resources, especially in healthcare education. To this extent, there is no development framework for the co-creation for virtual reality reusable e-resources utilising stakeholder participation.</p> <p>The successful candidate will be: (1) designing and developing Virtual Reality environments; (2) programming tracking devices (such as Arduinos), and or bio-signal devices (such as myo armband) suitable to the needs of a people with dementia and cancer patients; and (3) analysing bio-signals.</p>
Required Skills	<ul style="list-style-type: none"> <li>• Bachelor or master's degree in one of the following areas or a related area: computer science, graphic design, digital arts, cognitive systems.</li> <li>• Programming skills in C++ or C#, and familiarity with game engines such as Unity3D and Unreal Engine. Experience with VR development.</li> <li>• Ability to create 3D models to be used in VR applications. Proficiency in 3DS Max, Maya or other 3D modeling software and Photoshop. Knowledge and ability to implement the full game asset pipeline, with experience in Substance Design a plus.</li> <li>• Bio-signals Analysis skills, preferably in Electrocardiography (ECG), Photoplethysmogram (PPG), Electromyography (EMG), Electrodermal Activity (EDA).</li> </ul>

Internship Title	<a href="#">Virtual Reality for Cognitive Training in People with Dementia</a>
Description of Internship	People with dementia residing in long-term care are usually facing numerous cognitive impairments and go through several therapeutic cognitive trainings. In recent years, there have been a growing research interests towards designing non-pharmacological interventions aiming to improve the quality of life for people with dementia within long-term care. We are currently exploring the use of Virtual Reality for patients with mild, moderate, and severe dementia. With this project aims to explore the appeal of using Virtual Reality for people with dementia, and the observed impact such interaction has on their cognitive trainings.
Required Skills	The successful candidate will be responsible for the development of the Virtual Reality application. Therefore, the successful candidate should have a bachelor or master's degree in one of the following areas or a related area: computer science, computer graphics/graphic design, digital arts, cognitive systems. The successful candidate should have programming skills and familiarity with game engines such as unity3d and unreal engine.
Level of required Skills	Advanced.
Internship Objectives	The successful candidate will be responsible for the development of the Virtual Reality application.

Internship Title	<a href="#">Virtual Reality for Psychotherapy in Breast Cancer Patients</a>
Description of Internship	In recent years there have been a growing research interest towards designing computer-assisted health interventions aiming to improve mental health services. Digital technologies are becoming common methods for diagnosis, therapy, education, and training. With the advent of lower-cost Virtual Reality Head-Mounted-Displays (HMDs) and high internet data transfer capacity, there is a new opportunity for applying immersive Virtual Reality tools to augment existing interventions. Covid19 has enhanced the need of developing tools that can aid recovery for the patient from their personal space. This project aims to explore the use of Virtual Reality as a therapeutic medium for breast cancer patients dealing with body image dissatisfaction due to lymphedema body shape concerns. The goal of the study is to examine the opportunities Virtual Reality could offer for interventions, capitalising on the success of past Virtual Reality-based therapies.
Required Skills	The successful candidate will be responsible for the development of the Virtual Reality application. Therefore, the successful candidate should have a bachelor or master's degree in one of the following areas or a related area: computer science, computer graphics/graphic design, digital arts, cognitive systems. The successful candidate should have programming skills and familiarity with game engines such as unity3d and unreal engine. The ability to create 3d models to be used in Virtual Reality applications, proficiency in 3ds max, maya or other 3d modelling software and photoshop, as well as knowledge to implement the full game asset pipeline, with experience in substance design will considered as a plus.
Level of required Skills	Advanced.
Internship Objectives	The successful candidate will be responsible for the development of the Virtual Reality application.

Internship Title	<a href="#">Chatbots Enhance personalised European Healthcare Curricula (CEPEH)</a>
Description of Internship	Personalized Healthcare education is more than ever needed nowadays. There is growing evidence around chatbots, machine conversation systems, that these programs have the potential to change the way students learn and search for information. Chatbots can quiz existing knowledge, enable higher student engagement with a learning task or support higher-order cognitive activities. In large-scale learning scenarios with more than 100 students per lecturer, chatbots can solve the problem of individual student support and contribute to personalised learning. However, limited examples of chatbots in European Healthcare Curricula have been utilized to combine both the continuum of cognitive processes with the idea that some repetitive tasks can be done with a chatbot to provide greater access or to scale faculty time. Thus, CEPEH, an ERASMUS+ strategic partnership will co-create open access chatbots utilizing artificial intelligence promoting innovative practices in digital era, by supporting current curricula and fostering open education.
Required Skills	The successful candidate will be responsible for the development of the chatbot application. Therefore, the successful candidate should have a bachelor or master's degree in one of the following areas or a related area: computer science, computer graphics/graphic design, digital arts, cognitive systems. The successful candidate should have programming skills and familiarity with engines such as python and Rasa. The ability to create applications using Python.
Level of required Skills	Advanced.
Internship Objectives	The successful candidate will be responsible for the development of the chatbot application.

Internship Title	<a href="#">Augmented Reality in Medical Education</a>
Description of Internship	Augmented reality seems to be ubiquitous recently and most associated with gaming technology, but when we zoom out, AR has the capacity to positively influence several industries, one being healthcare. AR applications enable medical professionals to recreate real-world images of anatomical structures virtually, an image they can then project onto the surgical site in real-time using the HMD technology. Essentially this is a form of data visualization—a high-resolution projection of patient vitals and other relevant information that the surgeon would normally have to divert attention to obtain. Medical students can undergo the stress of mid-surgery mishaps and experience the pressure of reacting logically in unfavorable scenarios without real-life implications. This project aims to explore the use of Augmented Reality as an application for medical student's practice.
Required Skills	The successful candidate will be responsible for the development of the Augmented Reality application. Therefore, the successful candidate should have a bachelor or master's degree in one of the following areas or a related area: computer science, computer graphics/graphic design, digital arts, cognitive systems. The successful candidate should have programming skills and familiarity with python.
Level of required Skills	Advanced.
Internship Objectives	The successful candidate will be responsible for the development of the Augmented Reality application.

## MRG: Pervasive Real-World Computing for Sustainability (SuPerWorld)

Internship Title	Identifying parcels suitable for forestation
Description of Internship	<p>The goal is to use satellite imagery and computer vision to identify public parcels around Cyprus which are suitable for afforestation. These parcels need to be both public and unused, i.e. without any developments/infrastructures inside. The selected parcels will be shared to the Government of Cyprus to facilitate its efforts in reforestation.</p> <p>More info about the group's research: <a href="http://superworld.cyens.org.cy">http://superworld.cyens.org.cy</a></p>
Required Skills	Satellite imagery, deep learning (tensorflow/keras), computer vision, GIS (basic)
Level of required Skills	Good/advanced
Internship Objectives	Identify public parcels which are suitable for forestation
Expected Deliverables	Classification model, GIS visualizations

Internship Title	Why are bees declining in Cyprus and globally?
Description of Internship	<p>As bees constitute the main pollinators for local flora, it is important to keep the bee population steady and healthy. For bees, the biggest problems they face include parasites (e.g. the Varroa Destructor parasite), pesticides (i.e. bees cannot function on plants that have been sprayed with artificial pesticide), radio waves from telephones (i.e. distort their orientation) and land use change, which is responsible for reducing its potential space for settling its base (colony).</p> <p>To counteract the extinction of bees, we propose in this pilot the development of smart beehives. Via embedded sensors, placed inside our custom beehive boxes, we will monitor the micro-climate of the hive from the inside (i.e. temperature, humidity, noise), as well as count the number of bees that inhabit the "smart hive", keeping statistics about the daily in- and out-flux of the bees. Environmental and counting data would be transferred to a web/mobile app which would give to the owner valuable insights, in order to maintain the wealth of the hive.</p> <p>More info about the group's research: <a href="http://superworld.cyens.org.cy">http://superworld.cyens.org.cy</a></p>
Required Skills	Sensor technologies, Arduino programming
Level of required Skills	Good/advanced
Internship Objectives	Develop the smart bee hives and deploy them in different areas around Cyprus for small pilots
Expected Deliverables	Graphs, statistics and reports

Internship Title	<a href="#">Monitoring rodents via radar technology</a>
Description of Internship	<p>MED4PEST is a European project that aims to develop proven, effective Ecologically Based Rodent Management (EBRM) methods and products, which are readily integrated into local pest /invasive rodent management systems in Mediterranean countries, contributing to the shift from synthetic pest control to biological and ecological pest management, ultimately leading to eco-sustainable farming systems, higher quality and quantity crop production and optimization of input use for ecosystem health. This project contributes to a significant part of the European MED4PEST (bigger) project, which is about employing smart emerging technologies to monitor and observe rodents, understanding their behaviour, especially in relation to different stimuli in the environment (e.g. different types of bait).</p> <p>More info about the project:  <a href="https://superworld.cyens.org.cy/project17.html">https://superworld.cyens.org.cy/project17.html</a>  <a href="https://prima752537644.wordpress.com">https://prima752537644.wordpress.com</a></p> <p>More info about the group's general research: <a href="http://superworld.cyens.org.cy">http://superworld.cyens.org.cy</a></p>
Required Skills	Sensor technologies, Arduino programming
Level of required Skills	Good/advanced
Internship Objectives	Develop smart monitoring stations along the divide (demilitarized zone between Greek- and Turkish-Cypriot communities, to understand the dynamics of rodent populations along the line.
Expected Deliverables	Smart monitoring station, dataset created, perhaps also an algorithm applied for detecting, classifying and/or counting rodents

## MRG: Museum Lab

Internship Title	<b>Archival research, documentation and annotation</b>
Description of Internship	The intern will work on the DeepNic project which investigates the transformation of the urban centre of Nicosia from 1960 until 2020, using several types of data. The intern will help with research in photographic archives, collection of photographs and their documentation and annotation in a dataset.
Required Skills	<ul style="list-style-type: none"> <li>- Possible degrees: History, Architecture, Photography,</li> <li>- Basic computer skills and the internet</li> <li>- Interest in photography</li> <li>- Familiarity with archival research or digital repositories</li> <li>- Knowledge of the urban centre of Nicosia</li> </ul>
Level of required Skills	
Internship Objectives	The intern is expected to create a database of photographs on certain points of interest in the urban centre of Nicosia which will be incorporated into an interactive map

Internship Title	<b>Application of Emerging Technologies in Museum Environments</b>
Description of Internship	Emerging technologies are becoming an important part in the interpretation, education, and overall enhancement of the visitor experience in museums and heritage sites. We are looking for interns interested to work on researching various aspects of the application of these technologies in museum environments, with a special focus on the visitor experience.
Required Skills	<ul style="list-style-type: none"> <li>• Knowledge of qualitative research methodologies such as interviews, surveys and overall familiarity with qualitative data analysis</li> <li>• Knowledge of quantitative data analysis and of SPSS software</li> </ul>
Level of required Skills	Good knowledge
Internship Objectives	The Internship will include tasks relating to the review of relevant literature, analysis of qualitative and quantitative data and also data collection through survey questionnaires

## MRG: Cognitive and Clinical Applications (CCAPPs)

Internship Title	Cognitive skills in sports
Description of Internship	The intern(s) will assist in the collection of data on a behavioral study aims to assess the role of cognitive skills in fast-paced sports.
Required Skills	A background in Psychology or Neuroscience and statistical skills.
Internship Objectives	To collect and analyze data from experiments with human participants

Internship Title	Pain rehabilitation for musicians using virtual reality and eletromyography
Description of Internship	The intern(s) will work on a project that aims to build a virtual reality neurofeedback tool that helps musicians improve their postures during instrument playing.
Required Skills	Skills in mathematics and statistics, experience with physiological measures will be a plus.
Internship Objectives	To assist in the design of the prototype tool

## MRG: Visual Computing Group (VCG)

Internship Title	BuildingNet: Learning to Label 3D Buildings
Description of Internship	BuildingNet is a large-scale dataset of annotated 3D building models whose exteriors and surroundings are consistently labeled. The dataset provides 513K annotated mesh primitives, grouped into 292K semantic part components, across 2K building models. The dataset covers several building categories, such as houses, churches, skyscrapers, town halls, libraries, and castles. Two tracks are included in our benchmark. In the first track, called "BuildingNet-Mesh", algorithms can access the mesh data, including subgroups, thus leveraging pre-existing mesh structures common in 3D building models. The algorithms are evaluated in two conditions: when the RGB texture is available, and when it is not. In the second condition, algorithms must label the building using only geometric information. The second track, called "BuildingNet-Points", is designed for large-scale point-based processing algorithms that must deal with unstructured point cloud data without access to mesh structures or subgroups. This dataset is a joint work between UMass, CYENS (Visual Computing Group), and Adobe Research.
Required Skills	Basic knowledge of computer vision and deep learning. Programming skills: Python, TensorFlow (optional), PyTorch (optional)
Level of required Skills	Intermediate
Internship Objectives	The internship involves evaluating existing 3D semantic segmentation deep learning-based methods on the BuildingNet benchmarks and contributing towards a novel Graph Neural Network architecture, that can exploit the spatial and structural relations between



	the geometric primitives that compose a 3D building. The successful candidate will also have a chance to contribute to the actual dataset, mainly by refining the semantic parts of some of the building models.
Expected Deliverables	Final Report, Source Code, Trained models, Dataset

Internship Title	<b>Neural 3D Reconstruction</b>
Description of Internship	<p>3D reconstruction is a classic scene understanding task with applications ranging from robotics to architectural and surveying scenarios. In the classic reconstruction pipeline, a set of RGB images of a 3D scene or 3D shape are provided to the algorithm, which then proceeds to retrieve the camera locations and poses, as well as a sparse point cloud representing the 3D geometry, in a process called Structure from Motion (SfM)]. The following step then refines predictions and extracts dense point clouds via the multi-view stereo (VMS) triangulation process. Finally, the underlying surface is discretized via a meshing process such as screened Poisson reconstruction.</p> <p>Recent advances in machine learning have led to increased interest in solving the 3D reconstruction problem using coordinate-based neural networks. These methods, called neural fields, parameterize the physical properties of scenes or shapes across space. Neural fields store quantities like radiance (appearance) or distance/density (geometry) defined for all spatial coordinates and are parameterized by a neural network.</p> <p>A large amount of work is focused on reconstructing scene/shape representations, either of geometry in the form of signed distance functions (SDFs) given 3D supervision, or appearance by adopting neural volume rendering. In the first case, neural SDF-based methods can faithfully reconstruct a 3D surface by encoding an implicit geometric field. In the latter scenario, novel views of the 3D scene can be produced by leveraging neural radiance fields (NeRFs), that show promising results in reproducing the appearance of an object or a scene. One main drawback of many of these methods is that they are scene-specific, i.e., the neural network needs to be optimized for each scene independently, thus they cannot generalize to unseen objects or scenes.</p>
Required Skills	Basic knowledge of computer vision and deep learning. Programming skills: Python, TensorFlow (optional), PyTorch (optional)
Level of required Skills	Intermediate
Internship Objectives	The internship involves combining both approaches (SDF + NeRF) to reconstruct a surface's appearance and geometry. Additionally, deep MVS techniques that encode prior geometric cues will be investigated, which can help model a neural radiance and SDF field of new scenes much faster than previous approaches.
Expected Deliverables	Final Report, Source Code, Trained models

Internship Title	<b>Semantic 3D Segmentation for Scene Understanding</b>
Description of Internship	Semantic 3D segmentation is a task essential to applications that require an understanding of real-world 3D scenes, such as robotics, artificial intelligence (AI), augmented or virtual reality (AR/VR), and autonomous navigation/driving. The successful candidate is expected to conduct research at the intersection of computer vision, computer graphics, and machine learning, by integrating concepts and methods from these areas to advance the state of the art in 3D scene understanding.
Required Skills	Basic knowledge of computer vision and deep learning. Programming skills: Python, TensorFlow (optional), PyTorch (optional)
Level of required Skills	Intermediate

Internship Objectives	The scientific objectives of the project span a range of topics from these research areas, including data collection, neural networks training, evaluation, and application development, with the final goal to develop a novel deep learning architecture for semantic 3D segmentation, composed of deep neural networks for segmenting and labeling real-world objects and scenes.
Expected Deliverables	Final Report, Source Code, Trained models

Internship Title	<b>Conditional facade synthesis</b>
Description of Internship	<p>Current state-of-the-art generative networks can generate high-quality photorealistic images by approximating real data distributions. Conditional generative models can control the style and structure of the output sample to ensure that desired features exist on fake-generated images while maintaining high-quality photorealistic results.</p> <p>The successful candidate is expected to use state-of-the-art generative models and conduct a complete experiment with quantitative and qualitative comparisons.</p> <p>This internship aims to create a model that synthesizes a facade given semantic segmentation maps as inputs. The training will be based in a supervised manner with the creation of a paired dataset that correlates real and semantically annotated images.</p> <p>The first step of the project is to use conditional neural layers to assemble a model that takes the semantic segmentation mask as input and conditions the generative procedure toward a specific facade structure.</p> <p>The second step of the project aims to incorporate style conditional information. This will enable controllability on the generated images by manipulating the style of the facade's features such as the 1) color/ architectural style 2) windows 3) doors and 4) balconies style.</p> <p>The successful candidate is expected to experiment with both probabilistic denoising diffusion and Generative Adversarial networks.</p>
Required Skills	Good understanding of computer vision and deep learning. Familiar with PyTorch (developed at least 1-2 simple projects with this framework)
Level of required Skills	Intermediate
Internship Objectives	This project aims to work with state-of-the-art conditional generative models on creating photorealistic facades with controllable features and structure.
Expected Deliverables	Final Report, Source Code, Trained models

## MRG: Living, Breathing Virtual Worlds(V-EUPNEA)

Internship Title	<b>Artist friendly methods to populate virtual environments</b>
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Description of Internship	We aim to develop techniques to design, control and simulate multiple characters with different behaviors that can then be applied to different environments in various application domains (computer games, movies, urban studies, etc.). Designers should have maximum level of control of the generated simulation results with minimal user intervention. Characters should exhibit both high level behaviours such as reasoning and path planning and low-level ones such as navigation with collision avoidance and individual character animations. Additionally, animated characters can be of different types such as virtual humans, vehicles and animals. We aim to have easy and efficient multi-character design and control using notions known to animators from existing tools such as copy-pasting, painting with strokes, blending, etc. Since people are accustomed to using examples in order to describe desired requirements, we are interested in investigating novel methods that take as input exemplars of animated scenes (e.g., people behaving as one expects in a shopping street) and then given a new environment, output semantically correct behaviours for the animated characters.
Internship Title	<b>Robust Photogrammetry</b>
Description of Internship	Photogrammetry is the process by which one can reconstruct 3D scenes using a set of photographs. The quality of results is greatly affected by several factors; quality of photographs, lighting conditions, the presence of moving objects (Cars, pedestrians), the presence of reflective surfaces. Moreover, a very important limiting factor is the amount of data to be processed (photographs, point clouds). In this internship we will examine several techniques to tackle these issues including Deep Learning, Clustering and Anomaly Detection. Knowledge of Python and Deep Learning frameworks are recommended, but not mandatory.
Required Skills	Python Some tasks require Deep Learning in Python (PyTorch, Tensorflow, Keras) Some tasks require basic understanding of Machine Learning (Clustering, Anomaly Detection) and Image Handling
Level of required Skills	Very Good/Excellent
Internship Objectives	Development of Models and Tools
Expected Deliverables	Machine Learning Models and Tools

Internship Title	<b>Real-time Performance Capture</b>
Description of Internship	Performance capture is the process of capturing the performance of a human actor using several motion capture technologies. In the project we will combine several motion capture technologies (optical, inertia and markerless) to capture in real-time the body, facial and hand movement to animate in real-time virtual characters. The capturing process will also involve props such as chairs, swords, etc. Knowledge and experience with at least one game engine (preferably Unity or Unreal) or with Computer Graphics and Animation are required.
Required Skills	Experience with a Game Engine (Unity, Unreal preferred)
Level of required Skills	Very Good
Internship Objectives	Capture human performance

Expected Deliverables

Pipeline to capture human performance in real-time

# MRG: Real-time Populated Virtual Environments

Internship Title	Simulation and animation of pedestrian-vehicle interactions
Description of Internship	This project aims to develop algorithms for crowd simulation in urban environments, in the presence of vehicles. It will built on our recent crowd simulation work and will use machine learning techniques.
Required Skills	Computer programming, mathematics and ideally computer graphics or machine learning
Level of required Skills	As a minimum, the intern needs to have completed 3 years of undergrad studies.
Internship Objectives	Develop and test algorithms for crowd simulation

## MRG : Extended Experiences (EX)

Internship Title	Mobile Augmented Reality Recoloring Tool
Description of Internship	The focus of the internship is to develop a tool in augmented reality for recoloring virtual information (3D objects and text) according to the background. Different recoloring techniques will be investigated to enhance the quality of integration of virtual objects in different scenarios. Virtual content will be recolored according to specific logic to generate a more appealing and visual aesthetic view to the user. Efforts along these lines may therefore positively influence several application domains such as entertainment, creative industries and manufacturing.
Required Skills	<ol style="list-style-type: none"> <li>1. Knowledge of augmented reality/virtual reality</li> <li>2. Computer programming skills and Unity game Engine</li> <li>3. Basic knowledge in image processing</li> <li>4. Mobile application development</li> </ol>
Level of required Skills	Good
Internship Objectives	<ol style="list-style-type: none"> <li>1. Implement image processing algorithms for color harmonization</li> <li>2. Develop an augmented reality application for recoloring</li> <li>3. Design at least 3 different case-studies</li> <li>4. Benchmark/evaluate the application</li> </ol>
Supervisor	Dr Fotis Liarokapis

Internship Title	Mobile Augmented Reality Heritage Guide
Description of Internship	The focus of the internship is to develop an interactive augmented reality guide for Amathus ancient port. The ancient town of Amathous is located on the south coast of Cyprus, about 7 km east of the city of Limassol. A novel mobile augmented reality interface will be developed offering unique user experience. Tracking will be performed using sensors belonging to the mobile device (i.e. GPS and orientation sensors). Interaction will be based on the device and/or on the sensors of the device. The graphical user interface will be designed and optimised for offering different types of information (i.e. 3D objects, textual information, images).
Required Skills	<ol style="list-style-type: none"> <li>1. Knowledge of augmented reality/virtual reality</li> <li>2. Computer programming skills and Unity game Engine</li> <li>3. Basic knowledge in 3D modeling</li> <li>4. Mobile application development</li> </ol>
Level of required Skills	Good

Internship Objectives	<ol style="list-style-type: none"> <li>1. Generate the content that will be used for visualisation</li> <li>2. Develop an augmented reality application for heritage guide</li> <li>3. Design at least 3 different case-studies</li> <li>4. Benchmark/evaluate the application</li> </ol>
Supervisor	Dr Fotis Liarokapis

Internship Title	<b>Immersive EEG Framework</b>
Description of Internship	An electroencephalogram (EEG) is a test used to evaluate the electrical activity in the brain. Currently virtual reality provides an ideal medium to be combined with EEG technology and perform a variety of experiments. The aim of this internship is to design an immersive EEG framework based on virtual reality.
Required Skills	Excellent
Level of required Skills	<ol style="list-style-type: none"> <li>1. Knowledge of augmented reality/virtual reality</li> <li>2. Good computer programming skills and Unity game Engine</li> <li>3. Good knowledge of EEG and signal analysis</li> <li>4. Good knowledge of experimental design</li> </ol>
Internship Objectives	<ol style="list-style-type: none"> <li>1. Develop a generic virtual reality framework based in Unity and OpenVibe</li> <li>2. Design a generic experimental methodology for immersive EEG environments</li> <li>3. Perform data analysis</li> </ol>
Supervisor	Dr Fotis Liarokapis

## MRG: Fairness and Ethics in AI – Human Interaction (fAIre)

<b>Internship Title</b>	<b>Tools for Education on Fairness, Accountability, Transparency and Ethics (FATE) in AI</b>
<b>Description of Internship</b>	<p>We are again facing a new wave of automation, brought about by the advances in the field of artificial intelligence (AI). “Narrow AI” or targeted applications of AI that address specific tasks, have advanced in recent decades, as a result of robust “big data” architectures as well as the rise of self-learning algorithms (e.g., advanced neural network machine learning - “deep learning”). Narrow AI is already having significant impact on business and society, and is expected to trigger a “Fourth Industrial Revolution.”<sup>2</sup> In the past two years, major business consulting firms, such as PwC<sup>3</sup>, KPMG<sup>4</sup>, McKinsey<sup>5</sup> and others, have rolled out specialized services aimed at helping clients harness the benefits of digitally-enabled automation and narrow AI, preparing them for its impact on their workforces. Likewise, technologists, such as those involved in the <i>Stanford University 100 Year Study on AI</i> initiative<sup>6</sup>, are trying to anticipate not only the technological advances we will witness in the coming decades, but also how they will impact the way we live and work.</p> <p>A 2018 report, by the women-led organization AI Now,<sup>7</sup> describes an ethical crisis in AI, citing the large-scale experimentation on users of proprietary social media platforms (e.g., Facebook’s 2014 experiment on users’ moods, which also involved academic researchers<sup>8</sup>), as well as increasing surveillance of private citizens. Moreover, as stressed at the AI Now 2018 Symposium<sup>9</sup> ethically driven AI is more difficult to implement than what researchers thought it would be, as what constitutes “ethical behavior” differs across cultures and contexts. Clearly, governments and educational authorities across Europe need to step in and revisit the skills and competencies that young children and teens need to develop, in order to be active and informed European citizens, who can compete in the labour market of the future. As reported at the World Economic Forum,<sup>10</sup> “<i>Education can’t keep up with our fast-moving world.</i>” Thus, we developed tools and methodologies to equip the current and future generations with “healthy” AI related skills and competencies. However, we need to understand how the people who are interacting with these tools perceive the concepts we aim to convey and how effective these are.</p>
<b>Required Skills</b>	<p>Be able to</p> <ul style="list-style-type: none"> <li>● Perform a literature review;</li> <li>● Define research questions;</li> <li>● Decide on methods to be followed for answering the defined research questions;</li> </ul>

<sup>2</sup> [http://www.europarl.europa.eu/RegData/etudes/STUD/2018/626074/IPOL\\_STU\(2018\)626074\\_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2018/626074/IPOL_STU(2018)626074_EN.pdf)

<sup>3</sup> <https://www.pwc.com/gx/en/services/people-organisation/publications/workforce-of-the-future.html>

<sup>4</sup> <https://advisory.kpmg.us/articles/2018/future-of-work.html>

<sup>5</sup> <https://www.mckinsey.com/~media/mckinsey/featured%20insights/europe/shaping%20the%20future%20of%20work%20in%20europe%20nine%20digital%20front%20runner%20countries/shaping-the-future-of-work-in-europes-digital-front-runners.ashx>

<sup>6</sup> <https://ai100.stanford.edu/2016-report>

<sup>7</sup> <https://ainowinstitute.org/reports.html>

<sup>8</sup> <https://www.theguardian.com/technology/2014/jul/02/facebook-apologises-psychological-experiments-on-users>

<sup>9</sup> <https://www.technologyreview.com/s/612318/establishing-an-ai-code-of-ethics-will-be-harder-than-people-think/?source=download-metered-cont>

<sup>10</sup> <https://www.weforum.org/agenda/2017/06/new-approaches-education-changing-society>



	<ul style="list-style-type: none"> <li>● Design, develop and use data collection instruments e.g., focus groups, questionnaires, interviews;</li> <li>● Collect and analyze the data;</li> <li>● Write-up the results;</li> </ul>
<b>Level of required Skills</b>	
<b>Internship Objectives</b>	The FAIRE is designing and implementing a tool that demonstrates filter bubbles due to over-personalization, based on the user's characteristics and interactions. The aim of this project is to set up a user study based on the literature review performed, to understand the user interaction with the tool and its effect on user awareness and understanding about filter bubbles, using appropriate methods and instruments.
<b>Expected Deliverables</b>	

<b>Internship Title</b>	<a href="#">Multipurpose Crowdsourcing Interface Platform</a>
<b>Description of Internship</b>	<p>Given the potential of algorithmic systems to influence the social world, by amplifying or abating bias and potential discrimination, this internship will aid towards the detection of social bias at the input and output data of an Artificial Intelligence (AI) application. The focus of the internship will be on the expression of social stereotypes (e.g., based on gender, race or socio-economic status) and how those are reflected in biases shared by groups of people interacting in different ways with the AI system. We envision a human-in-the-loop approach, methodically exposing social stereotypes and reducing the negative impact or even enhancing people's access to opportunities and resources when interacting with both high and low risk AI applications. By engaging humans in the evaluation process (i.e., through crowdsourcing), we will achieve a diverse (e.g., across cultures) and dynamic (e.g., across contexts and time) evaluation of social norms, according to the objective of the evaluated application.</p> <p>This internship will focus on computer vision applications that analyse people-related media (e.g., image content analysis or "fAlreging," gender or age recognition from a profile photo) with significant implications for high-risk applications (e.g., screening job applicant profiles or dating applications).</p>
<b>Required Skills</b>	<p>The intern must be a junior or senior university student (3rd year of studies or above) in Computer Science or related fields of study.</p> <p>The successful applicant must have advanced knowledge in:</p> <ul style="list-style-type: none"> <li>● Web development</li> <li>● UI system design</li> </ul> <p>Knowledge of the following will be considered a plus:</p> <ul style="list-style-type: none"> <li>● Knowledge of AWS</li> <li>● Python or R programming language for data collection &amp; analysis</li> <li>● Amazon MTurk, Clickworker, Prolific or other crowdsourcing platforms</li> </ul>

<b>Level of required Skills</b>	Advanced
<b>Internship Objectives</b>	This internship will support the detection of social bias at the input and output data of an Artificial Intelligence (AI) application, by designing and creating a prototype of the interface environment with a crowdsourcing platform (i.e., Clickworker or Prolific ). The successful candidate may develop an online tool connected to a database for the collection of the answers received during the crowdsourcing process. The developed tool should allow the user to adjust the interface platform according to the specific crowdsourcing needs.
<b>Expected Deliverables</b>	The successful applicant will discuss with the FAIRE MRG team about the final expected deliverables. Although some main expected deliverables would be the following: <ul style="list-style-type: none"> <li>● Online tool, serving as the interface platform/environment with the crowdsourcing platform</li> <li>● An API for designing various crowdsourcing studies (i.e., non static interface with the crowdsourcing platform)</li> </ul>

<b>Internship Title</b>	<a href="#">Visual Disinformation in crisis-related content on the Web and Social Media</a>
<b>Description of Internship</b>	<p>The COVID-19 pandemic - and now the Ukrainian crisis - have underscored the need for tools and methodologies for combating online disinformation in ways that empower people, at the same protecting democratic values. While the detection of “fake news” is far from being a new topic, the urgency and the universality of these unprecedented situations has resulted in renewed attention to the spread of disinformation on the Web and in social media.</p> <p>Recent research has revealed the significant role that <i>visual artefacts</i> - such as images and memes - play in the spread of misinformation and disinformation. Visuals are important because they serve as indices, having a physical connection to their referent; thus, in contrast to symbols or icons, they are often viewed as being closer to the truth as compared to other forms of communication. Furthermore, although in recent years, there is a proliferation of research surrounding both the automated methods for the detection of misinformation as well as on media literacy for a range of stakeholders (from the role of teachers to professional journalists), few approaches focus specifically on visual information.</p> <p>This project aims to create a high-quality and valid dataset of crisis-related images (e.g., infographics, news covers, etc., concerning a topic of interest such as the Ukraine crisis or the pandemic.). The dataset will be annotated using a valid crowdsourcing methodology which will be discussed between the successful applicant and the FAIRE MRG team. The methodology might consist of data collection from the web or selected social media, while also will include the use of crowdworker platforms such as <i>Amazon MTurk</i> or <i>Appen</i>, or the in-house system of the team, <i>OpenFAire</i>. Another aim is to validate the developed dataset with public <i>fact-checking techniques or tools</i> to ensure the quality of the final product. Furthermore, basic research, data collection and analysis will be conducted to provide insights about the developed dataset.</p>
<b>Required Skills</b>	The intern must be a junior or senior university student (3rd year of studies or above) in Computer Science or related fields of study.

	<p>The successful applicant must have basic knowledge in:</p> <ul style="list-style-type: none"> <li>- Python or R programming language for data collection &amp; analysis</li> <li>- Using Amazon MTurk, Appen or other crowdsourcing platforms will be considered a plus</li> </ul> <p>Any prior knowledge or experience on the Risk Communication Theory or Fake News/Disinformation or Crowdsourcing via Crowdworkers will be considered as a plus.</p>
<b>Level of required Skills</b> <sup>11</sup>	<i>Basic</i>
<b>Internship Objectives</b>	<p>The project aims to design and execute several crowdsourcing studies using Amazon MTurk or Appen crowdworker platforms to annotate the gathered images for disinformation checking and answer to specific research questions. The successful applicant may develop Python/R tools for analyzing the collected data and conclude into findings, while he/she will be able to use some of the groups' prior research tools (eg. OpenFAIre platform). The project will involve work in data collection and analysis.</p>
<b>Expected Deliverables</b>	<p>The successful applicant will discuss with the FAIRE MRG team about the final expected deliverables. Although some main expected deliverables would be the following:</p> <ul style="list-style-type: none"> <li>- Python/R tools for analyzing the collected annotated datasets and overall responses</li> <li>- Data Analysis Report</li> </ul> <p>The team will ensure that the successful applicant will have the opportunity to get involved in a high-quality research environment and expert team, while also aiming to generate a paper for submission in a competitive Conference, Workshop, or Journal on the related topic. The publication will include the successful applicant's (intern) name as one of the authors of the current work.</p>

<b>Internship Title</b>	<b>A comparative study of dedicated platforms vs social media platforms for recruiting crowdsourcing participants</b>
<b>Description of Internship</b>	<p>The goal of the internship is to compare the performance of crowdsourcing platforms and social media platforms in recruiting participants for online studies. In particular, it will compare the two methods of recruiting participants in terms of bias and quality. Crowdsourcing platforms have the ability to offer access to a large and diverse set of participants, according to their claims, aiding the requester of a crowdsourcing study to find participants fast and efficiently. On the other hand recruiting participants through social media can provide larger transparency and better control of the sample of participants. This internship will particularly look at the competitive advantage that recruiting participants through social media might have against crowdsourcing platforms in the collection of emotions. During the internship, a crowdsourcing study will be developed to fulfill the goal above and the effectiveness of the two crowdsourcing methods will be tested by running the study on a crowdsourcing platform and a social media platform.</p>

<sup>11</sup> Assigning a scale from Basic, Competent, Intermediate, Advanced and Expert Level of Required Skills, based on the Competencies Proficiency Scale | Office of Human Resources

<b>Required Skills</b>	<p>Knowledge of Python or R and statistical concepts.</p> <p>Familiarity with crowdsourcing platforms.</p>
<b>Level of required Skills</b>	Intermediate
<b>Internship Objectives</b>	Identify and implement a crowdsourcing study in line with the goals of the project. Establish the effectiveness of the two crowdsourcing methods in terms of quality and bias, through data collection and analysis. Presentation of sufficient evidence on the superiority of one or the other approach for the crowdsourcing study considered.
<b>Expected Deliverables</b>	<p>By the end of the internship the following deliverables\milestones are expected to be delivered:</p> <ul style="list-style-type: none"> <li>- Brief literature review</li> <li>- Design and implementation of the crowdsourcing study</li> <li>- Data collection and analysis of the results.</li> <li>- Dissemination of the results.</li> </ul>

<b>Internship Title</b>	<u><a href="#">User perception of explanations provided in recommender systems</a></u>
<b>Description of Internship</b>	<p>According to the European Commission, “Artificial intelligence (AI) refers to systems that display intelligent behavior by analyzing their environment and taking actions – with some degree of autonomy – to achieve specific goals”.<sup>12</sup> Like all new and controversial technologies, AI has both benefits and risks, and since the development of AI based technologies is global and not centralized, it is difficult to regulate their advancement. For example, Machine Learning (ML) based AI systems that are trained on incomplete or unbalanced datasets may amplify social stereotypes, magnify prejudice and inequality, and increase the spreading of fake news, with real impact in the society (e.g., Google Photos Gorillas Incident<sup>13</sup> , COMPAS system for criminal sentencing<sup>14</sup>). Similarly, we have seen AI behaving unexpectedly in autonomous or semi-autonomous vehicles and on some occasions with fatal results<sup>15</sup>. There is also a misconception or a worry that future AI systems may completely take control and outright harm or reject humans.</p> <p>Human Centered AI research advocates that the next evolution of AI is not going to be only technological but also humanistic and ethical. Bridging the gap between technology, human aspects and ethics, researchers at Stanford believe that Human Centered AI research and development should empower human capabilities rather than replace them; understand and emphasize the impact of AI on humans; and technically reflect the depth</p>

<sup>12</sup> Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on Artificial Intelligence for Europe, Brussels, 25.4.2018 COM(2018) 237 final.

<sup>13</sup> <https://www.wired.com/story/when-it-comes-to-gorillas-google-photos-remains-blind/>

<sup>14</sup> <https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing>

<sup>15</sup> <https://www.lawyerc.com/blog/self-driving-car-accident-responsibility/>

	<p>characterized by human intelligence <sup>16</sup>. Augmented intelligence is a design pattern for a human-centered partnership model of people and AI working together to enhance cognitive performance, including learning, decision making and new experiences<sup>17</sup>. In this endeavor, industry has already made a shift into a more ethical, inclusive, responsible, human centered approach to AI development.<sup>18,19,20</sup> Currently, socially biased algorithms, unbalanced datasets, opacity of AI enabled software and hardware affect the way people interact with, trust, and make decisions based on an AI system’s output. As long as a non-technical user cannot understand how an opaque intelligent system came up with an output, whether they should trust, or when they should trust its judgment etc., adoption of AI technologies will be difficult to achieve.</p> <p>Firstly, we need to understand how humans perceive their interaction with AI, what is the mental model a user has when interacting with an AI enabled technology, and possible cognitive biases they might have.</p> <p>Next, the technology needs to adapt to the humans’ needs and augment their capabilities by providing user-controlled personalization e.g., adaptive user interfaces, which could be adjusted to user preferences, characteristics, and mental model, among other parameters.</p> <p>Finally, communication and collaboration require exchanging of information. Explainable AI allows users to understand the algorithms and the parameters used in an AI black box problem. However, we need to acknowledge that different explanations and explainable interfaces are needed for the different users.</p>
<b>Required Skills</b>	<p>Be able to</p> <ul style="list-style-type: none"> <li>• Perform a literature review;</li> <li>• Define research questions;</li> <li>• Decide on methods to be followed for answering the defined research questions;</li> <li>• Design, develop and use data collection instruments e.g., focus groups, questionnaires, interviews;</li> <li>• Collect and analyze the data;</li> <li>• Developing a prototype</li> <li>• Write-up the results;</li> </ul>
<b>Level of required Skills</b>	
<b>Internship Objectives</b>	<p>i) Taking into consideration the above, and looking into the research work on Algorithmic Fairness, Transparency and Explainability, you are asked to propose a method through which you will investigate how users (people with no technical experience in different age groups) perceive the explanations provided by recommendation systems e.g. Facebook on the Advertisements that are appearing on their wall, or Netflix, etc.</p> <p>ii) Propose a demo tool that you would design for explaining to the above audience how explanations work for different purposes on recommendation systems.</p>

<sup>16</sup> Li, F.F. and Etchemendy, J. A common goal for the brightest minds from Stanford and beyond: Putting humanity at the center of AI. 2018; <https://hai.stanford.edu/news/introducing-stanfords-human-centered-ai-initiative>

<sup>17</sup> <https://www.gartner.com/en/information-technology/glossary/augmented-intelligence>

<sup>18</sup> <https://www.ibm.com/design/ai/>

<sup>19</sup> <https://pair.withgoogle.com/>

<sup>20</sup> <https://www.microsoft.com/en-us/research/project/guidelines-for-human-ai-interaction/>

## FRG: Adaptive Video Processing, Analytics and Communications for Real-Time Applications (VIDEOMICS)

Internship Title	<a href="#">Comparative Performance Evaluation of Video Codecs</a>
Description of Internship	<p>Video compression is the core technology in video streaming applications. With global video traffic surpassing 82% of all Internet traffic in 2022, there is a strong need to develop efficient compression algorithms to accommodate future growth.</p> <p>The internship will conduct performance evaluation of</p> <ul style="list-style-type: none"> <li>- Emerging (AV2, EVC, LCEVC), recently standardized (VVC, AV1), earlier (HEVC), and legacy but widespread (H.264, VP9) video codecs.</li> <li>- Objective video quality assessment will leverage PSNT, SSIM, and VMAF metrics.</li> <li>- Subjective video quality assessment experiments of &gt;10 participants will be further scheduled (optional).</li> <li>- Netflix, LIVE, and Medical video datasets will be used.</li> <li>- The implementation philosophy and source-code implementation guidelines will be provided.</li> </ul>
Required Skills	<ul style="list-style-type: none"> <li>- Good Programming Skills (Python and Bash Scripting for implementation; optional C and C++ for logic comprehension)</li> <li>- Basic understanding of Image/ Video processing</li> </ul>
Level of required Skills	- As above
Internship Objectives	- Investigate the strengths and weaknesses of each video compression standard and the trade-off between video quality, bitrate demands, and compression efficiency.
Reading	<ul style="list-style-type: none"> <li>- G. Esakki, A. S. Panayides, V. Jalta and M. S. Pattichis, "Adaptive Video Encoding for Different Video Codecs," in <i>IEEE Access</i>, vol. 9, pp. 68720-68736, 2021. doi: 10.1109/ACCESS.2021.3077313.</li> <li>- A. S. Panayides, M. S. Pattichis, M. Pantziaris, C.S. Pattichis, "The Battle of the Video Codecs in the Healthcare Domain - A Comparative Performance Evaluation Study Leveraging VVC and AV1," in <i>IEEE Access</i>, vol. 8, pp. 11469-11481, 2020. doi: 10.1109/ACCESS.2020.2965325</li> </ul>

Internship Title	<a href="#">Comparative Performance Evaluation of Video Codecs for 360° Videos</a>
Description of Internship	<p>Adaptive video streaming for 360° videos is much more computationally demanding and bandwidth-hungry than traditional 2D videos.</p> <p>The internship will compare:</p> <ul style="list-style-type: none"> <li>- Recently standardized VVC and AV1 as well as earlier HEVC video codecs and examine their performance in terms of encoding complexity, bandwidth demands, and video quality.</li> <li>- Objective video quality assessment will leverage PSNR and VMAF metrics.</li> <li>- Subjective video quality assessment experiments of &gt;10 participants will be further scheduled (optional).</li> <li>- Open-source 360o video datasets will be used.</li> <li>- The implementation philosophy and source-code implementation guidelines will be provided.</li> </ul>

Required Skills	<ul style="list-style-type: none"> <li>- Good Programming Skills (Python and Bash Scripting for implementation; optional C and C++ for logic comprehension)</li> <li>- Basic understanding of Image/ Video processing</li> <li>- Basic understanding of 360° Video Delivery</li> <li>- Basic understanding of Machine Learning Algorithms</li> </ul>
Level of required Skills	- As above
Internship Objectives	- Investigate the strengths and weaknesses of each video compression standard and the trade-off between video quality, bitrate demands, and compression efficiency with respect to 360° Video Delivery
Reading	<ul style="list-style-type: none"> <li>- G. Esakki, A. S. Panayides, V. Jalta and M. S. Pattichis, "Adaptive Video Encoding for Different Video Codecs," in <i>IEEE Access</i>, vol. 9, pp. 68720-68736, 2021. doi: 10.1109/ACCESS.2021.3077313.</li> <li>- A. S. Panayides, M. S. Pattichis, M. Pantziaris, C.S. Pattichis, "The Battle of the Video Codecs in the Healthcare Domain - A Comparative Performance Evaluation Study Leveraging VVC and AV1," in <i>IEEE Access</i>, vol. 8, pp. 11469-11481, 2020. doi: 10.1109/ACCESS.2020.2965325</li> </ul>

Internship Title	<a href="#">Video Analytics using Deep Learning Methods: How Compression comes into Play</a>
Description of Internship	<p>Video analysis pipelines using deep learning (DL) methods rarely address the compression ratio of the acquired video feed.</p> <p>The internship will examine edge scenarios aiming at identifying the breaking point of the video analysis outcome by:</p> <ul style="list-style-type: none"> <li>- Varying the compression levels of different video codecs supported by the DL model</li> <li>- Examining different, lightweight single-shot detector networks (i.e., YOLO, Mask R-CNN)</li> <li>- Investigating diverse video datasets</li> </ul>
Required Skills	<ul style="list-style-type: none"> <li>- Good Programming Skills (Python, C, C++)</li> <li>- Basic understanding of Image/ Video processing</li> <li>- Basic understanding of Machine Learning Algorithms</li> </ul>
Level of required Skills	- As above
Internship Objectives	- Hands on experience on video compression and video analytics tasks while investigating the crucial role video compression plays during computer vision tasks using deep learning models
Reading	<ul style="list-style-type: none"> <li>- G. Esakki, A. S. Panayides, V. Jalta and M. S. Pattichis, "Adaptive Video Encoding for Different Video Codecs," in <i>IEEE Access</i>, vol. 9, pp. 68720-68736, 2021. doi: 10.1109/ACCESS.2021.3077313.</li> <li>- A. S. Panayides, M. S. Pattichis, M. Pantziaris, C.S. Pattichis, "The Battle of the Video Codecs in the Healthcare Domain - A Comparative Performance Evaluation Study Leveraging VVC and AV1," in <i>IEEE Access</i>, vol. 8, pp. 11469-11481, 2020. doi: 10.1109/ACCESS.2020.2965325</li> </ul>

Internship Title	<a href="#">Adaptive Video Streaming Simulations</a>
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Description of Internship	<p>Adaptive video encoding can be formulated as a multi-objective optimization process where video quality, bitrate demands, and encoding rate are jointly optimized, going beyond the standard video encoding approaches that focus on rate control targeting specific bandwidths. The latter approach is applicable for industry-level adaptive video streaming solutions.</p> <p>The internship will use a python implementation of the afore-described approach and examine the use of different:</p> <ul style="list-style-type: none"> <li>- Video codecs (i.e., VVC, AV1, HEVC, H.264) to verify the codec-agnostic nature of the employed algorithms</li> <li>- Video quality assessment metrics (i.e., PSNR, SSIM, VMAF)</li> <li>- 3G/4G/5G network traces to simulate the adaptation efficacy of the approach in a variety of real-time video communication scenarios</li> <li>- Buffer fullness algorithms to showcase the applicability of the methods over various industry implementation setups</li> </ul>
Required Skills	<ul style="list-style-type: none"> <li>- Good Programming Skills (Python and Bash Scripting for implementation; optional C and C++ for logic comprehension)</li> <li>- Basic understanding of Image/ Video processing</li> <li>- Basic understanding of Statistics and Linear Regression</li> <li>- Basic understanding of Machine Learning Algorithms</li> </ul>
Level of required Skills	<ul style="list-style-type: none"> <li>- As above</li> </ul>
Internship Objectives	<ul style="list-style-type: none"> <li>- Hands on experience on adaptive video delivery for real-time applications using state-of-the-art video compression standards, video quality assessment metrics, and industry best-practises</li> </ul>
Reading	<ul style="list-style-type: none"> <li>- G. Esakki, A. S. Panayides, V. Jalta and M. S. Pattichis, "Adaptive Video Encoding for Different Video Codecs," in <i>IEEE Access</i>, vol. 9, pp. 68720-68736, 2021. doi: 10.1109/ACCESS.2021.3077313.</li> <li>- A. S. Panayides, M. S. Pattichis, M. Pantziaris, C.S. Pattichis, "The Battle of the Video Codecs in the Healthcare Domain - A Comparative Performance Evaluation Study Leveraging VVC and AV1," in <i>IEEE Access</i>, vol. 8, pp. 11469-11481, 2020. doi: 10.1109/ACCESS.2020.2965325</li> </ul>

Internship Title	<a href="#">Privacy Preserving Mechanisms for the Use of Robotic Vision Technologies in Indoor Spaces</a>
Description of Internship	<p>Robotic vision can be used for a diverse set of tasks ranging from safe and autonomous navigation, to localization, and floor mapping, among others.</p> <p>The internship will investigate best-practise setups involving human and object -aware navigation using video camera feed analysed using contemporary deep learning models. The objective will be to develop privacy-preserving mechanisms building on top of these approaches, towards mitigating privacy concerns for the use of robotic vision technologies in sensitive indoor spaces, such as hospitals.</p>
Required Skills	<ul style="list-style-type: none"> <li>- Good Programming Skills (Python, C, C++)</li> <li>- Basic understanding of Image/ Video processing</li> <li>- Basic understanding of Machine Learning Algorithms</li> <li>- Basic understanding of Robot Operating System (ROS)</li> </ul>
Level of required Skills	<ul style="list-style-type: none"> <li>- As above</li> </ul>



Internship Objectives	<ul style="list-style-type: none"> <li>- Hands-on experience on computer vision tasks using edge devices residing or real robots and interacting using the robot operating system (ROS). The internship is attached to real-life case studies emanating from the following H2020 research projects:</li> <li>- <a href="https://endorse-project.eu/">https://endorse-project.eu/</a></li> <li>- <a href="http://www.project-respect.eu/">http://www.project-respect.eu/</a></li> </ul>
Reading	<ul style="list-style-type: none"> <li>- Eftychios G. Christoforou, Sotiris Avgousti, Nacim Ramdani, Cyril Novales, and Andreas S. Panayides, "The Upcoming Role for Nursing and Assistive Robotics: Opportunities and Challenges Ahead," <i>Frontiers in Digital Health</i>, vol. 2. pp. 39, Dec. 2020. <a href="https://doi.org/10.3389/fdgth.2020.585656">https://doi.org/10.3389/fdgth.2020.585656</a></li> <li>- N. Ramdani, A. S. Panayides, M. Karamousadakis, <i>et al.</i>, "A Safe, Efficient and Integrated Indoor Robotic Fleet for Logistic Applications in Healthcare and Commercial Spaces: The ENDORSE Concept," <i>2019 20th IEEE International Conference on Mobile Data Management (MDM)</i>, Hong Kong, Hong Kong, 2019, pp. 425-430.</li> <li>- <a href="https://www.endorse-project.eu/">https://www.endorse-project.eu/</a></li> <li>- <a href="http://www.project-respect.eu/">http://www.project-respect.eu/</a></li> </ul>

Internship Title	Collaborative Robotic Vision Technologies for Indoor Spaces Applications
Description of Internship	<p>Robotic vision can be used for a diverse set of tasks ranging from safe and autonomous navigation, to localization, and floor mapping, among others.</p> <p>The internship will investigate best-practise setups involving collaborative robotic vision technologies for applications such as floor mapping and object detection and characterization. The idea is that fusing views coming from different robots and hence angles can provide a more accurate prediction of the objects in the robots' field of view.</p>
Required Skills	<ul style="list-style-type: none"> <li>- Good Programming Skills (Python, C, C++)</li> <li>- Basic understanding of Image/ Video processing</li> <li>- Basic understanding of Machine Learning Algorithms</li> <li>- Basic understanding of Robot Operating System (ROS)</li> </ul>
Level of required Skills	- As above
Internship Objectives	<ul style="list-style-type: none"> <li>- Hands-on experience on computer vision tasks using edge devices residing or real robots and interacting using the robot operating system (ROS). The internship is attached to real-life case studies emanating from the following H2020 research projects:</li> <li>- <a href="https://endorse-project.eu/">https://endorse-project.eu/</a></li> <li>- <a href="http://www.project-respect.eu/">http://www.project-respect.eu/</a></li> </ul>
Reading	<ul style="list-style-type: none"> <li>- Eftychios G. Christoforou, Sotiris Avgousti, Nacim Ramdani, Cyril Novales, and Andreas S. Panayides, "The Upcoming Role for Nursing and Assistive Robotics: Opportunities and Challenges Ahead," <i>Frontiers in Digital Health</i>, vol. 2. pp. 39, Dec. 2020. <a href="https://doi.org/10.3389/fdgth.2020.585656">https://doi.org/10.3389/fdgth.2020.585656</a></li> <li>- N. Ramdani, A. S. Panayides, M. Karamousadakis, <i>et al.</i>, "A Safe, Efficient and Integrated Indoor Robotic Fleet for Logistic Applications in Healthcare and Commercial Spaces: The ENDORSE Concept," <i>2019 20th IEEE International Conference on Mobile Data Management (MDM)</i>, Hong Kong, Hong Kong, 2019, pp. 425-430.</li> <li>- <a href="https://www.endorse-project.eu/">https://www.endorse-project.eu/</a></li> </ul>

## FRG: Neurocognitive Management of Occupational Movement Disorders (Neo-Move)

Internship Title	<b>Front-end Web Development and Social Media Management</b>
Description of Internship	<p>Our group deals with neurocognitive research and the development of tools for the prevention, diagnosis, and rehabilitation of primary and secondary movement disorders mainly in athletes, musicians, dancers, etc. The group combines musculoskeletal assessment such as electromyography with motion capture and extended reality technologies (AR, VR).</p> <p>The focus of the internship is the development of the group's website, collection of web-materials, management of the groups' social media accounts, and assisting other researches in conducting experiments.</p>
Required Skills	Knowledge on web development. Programming skills and data management will be a plus
Level of required Skills	Intermediate
Internship Objectives	To contribute to the visibility of the Neo-Move group and its projects. To assist in projects' development

## MRG: Real-time Populates Environments (RIPE)

Internship Title	Exploring Learned-Based Methods for Dynamic Keypoint Removal
Description of Internship	Estimating a camera pose (localization) is crucial for autonomous driving, robotics and augmented reality applications. Current map-based localization methods suffer from slow queries when point cloud data is accumulated over time. Several conventional methods use map compression to combat this problem. This project looks at the problem from a different point of view, it aims to explore current methods that remove dynamic keypoints (on humans, cars, vegetation) detected on a camera frame, instead of dealing with the offline map. The goal is to reduce the time is required to estimate a camera pose compared to conventional FLANN or Brute Force methods without loss of accuracy.
Required Skills	Strong Python and maths skills, exposure to C/C++. Familiar with OpenCV or similar libraries. Nice to have: Unity and Android development
Level of required Skills	BSc, MSc, PhD
Internship Objectives	Replicate existing learned based methods that aim in reducing dynamic keypoints on a frame Develop novel methods that reduce keypoints to the minimum required. This task will entail adding additional data or using a suitable cost function Compare the novel methods with the methods in literature. Time permitted, integration with a SLAM system