

ISTI NEWS

Open Science for Blue Growth



Árni Mathiesen (left), FAO Assistant Director-General, Fisheries and Aquaculture Department and Roberto Scopigno (right) Isti-Cnr Director. (Photo credit must be given: ©FAO/Alessandra Benedetti. Editorial use only. Copyright ©FAO)

Blue Growth is the European long-term strategy for the sustainable "growth" of the marine and maritime sectors.

It currently involves around 5 million jobs and 500 billion euros gross added value per year. Blue Growth requires solving problems that largely need to process Big Data through Artificial Intelligence models. *[continues on page 4]*



Telling the story of Armenian manuscripts

Three Armenian manuscripts from Florence dating back to the 13th and 14th centuries are now on display at the Matenadaran Museum in Yerevan...thanks to the efforts of the Italian Embassy and the Italian National Research Council (CNR). *[page 55]*

ERC AdG XAI:

Science and Technology for the eXplanation of AI Decision Making
Co-funded by European Commission

The XAI project, funded by an ERC Advanced Grant awarded to Fosca Gianotti, focuses on the urgent open challenge of how to construct meaningful explanations of opaque AI/ML systems. *[page 7]*



Editorial



Antonia Bertolino, Research Director, SEDC Lab

Test! Test!! Test!!!

That any software system should be adequately tested before going live nobody would argue. However, due to the increasing complexity and continuous evolution of software-intensive systems on the one side, and to time-to-market pressure on the other, it is rarely the case that the testing undergone by software products could be justifiably qualified as adequate.

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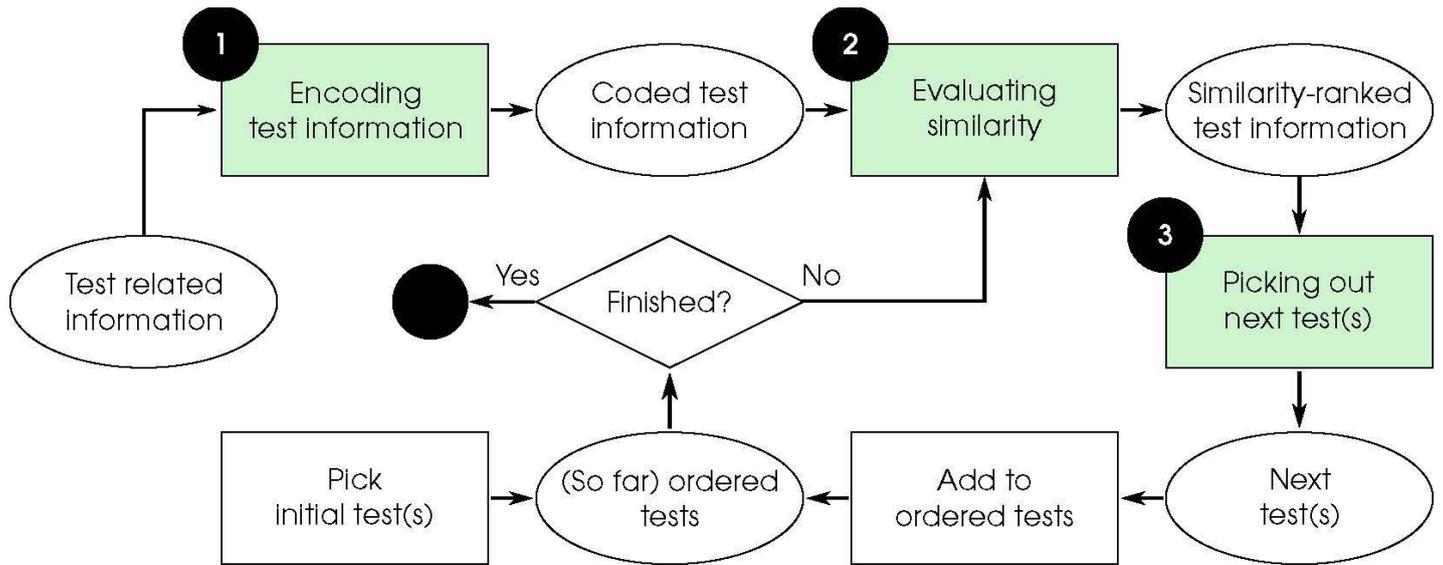
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Test! Test!! Test!!!



The process followed to choose the next test based on similarity

In modern hi-tech and interconnected society, software is pervasive and bugs can produce disastrous consequences, as expert insiders know well and as the general public rediscovers from time to time on reading the latest news about a serious accident attributed to a “software failure”. Through testing we aim at detecting these bugs as early as possible.

Software testing amounts to observing how a system behaves on a set of potential usage scenarios, the so-called test suite. Described like this, it might appear to be a simple or even trivial activity, but in reality the challenges that such testing exposes are many and of difficult solution. What are the most effective test cases to reveal existing bugs (a.k.a. the test selection problem)? How much testing is enough (the test adequacy or stopping problem)? How can we determine if the behavior observed is correct (test oracle problem)? In addition to these fundamental questions, other more technical problems will emerge depending on the testing context. For example, in continuous integration or DevOps paradigms, changes are introduced frequently, and this means that previously successful tests must be

continuously re-executed to ensure that no regression has occurred. For large-scale distribution products, many variations of configuration tests should be run, over a huge number of potential platforms or systems.

Research in software testing is very active: a systematic analysis that we conducted over the last five editions of the most prominent conferences in the area of software engineering revealed that it has been consistently the most frequent topic among the accepted research papers. At ISTI, we possess a long-term know-how in software testing, not only through many theoretical studies, but also in practical applications to certification. The groups that form the ISTI Thematic Area for Software, namely the Software Engineering and Dependable Computing Laboratory (SEDC), the Formal Methods and Tools Laboratory (FMT), and the System and Software Evaluation Center (SSE) have all contributed from different perspectives to advance the field.

Researchers from the SEDC laboratory are currently conducting a research project aimed at tackling very-large test suites: on the scale of giant platforms such as those

maintained by Google or Facebook, testing for non-regression entails executing millions of test cases every day. As such testing is a pre-requisite to releasing new changes to these platforms, fast and effective automated techniques are needed to address regression testing. Although in the past decade researchers have proposed many methods to select (i.e., choose a subset) or prioritize (i.e., re-order putting the most effective first) regression test cases, these methods cannot be applied on such large a scale, because they would take too long to complete. One class of methods that has been shown to be very effective in bug detection uses a concept of test case similarity: given that only a subset of test cases can be executed, these methods select a subset of the most dissimilar test cases, i.e., those that are the most distant from the others, according to some notion of “distance”. However, similarity-based testing is too demanding in computational terms: in our studies, we have observed that existing techniques took hours or even days to find a test subset when applied to million-size test suites.

To scale-up to such dimensions, we have developed the FAST family of similarity-based approaches to regression testing that evaluates the distance among the test cases by leveraging the different techniques adopted to search similar objects in the big data domain, together with some projection techniques that are useful to map the test code over a reduced point space. The results so far are impressive: for example, one method of the FAST family could select a predefined “budget” of test cases from a half-million sized test suite in less than 10 seconds, after just 5 minutes preparation time, with a negligible effectiveness loss in comparison to much more expensive approaches.

Most recently, we have applied the same idea of leveraging test code similarity to address another tough problem in industrial large-scale software testing, i.e., test flakiness. Flaky tests produce different outcomes non-deterministically, even when re-executed over the same version of a

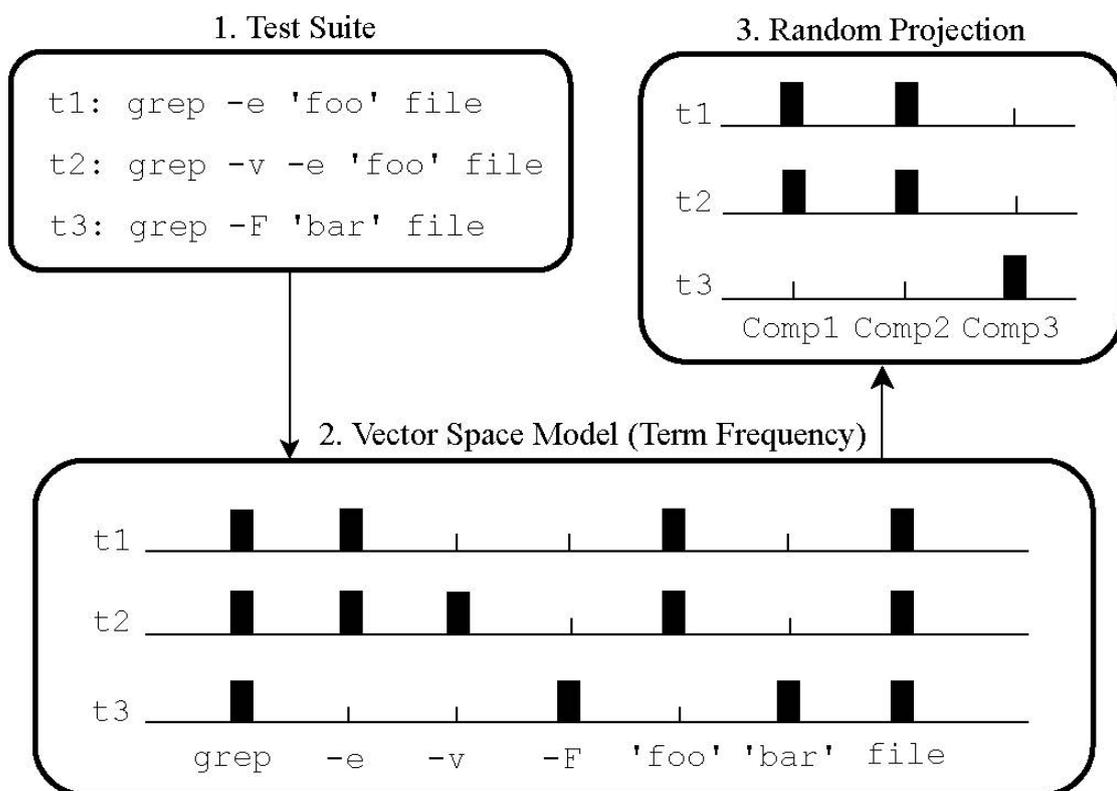
software system. This intermittent behavior is one of the most pressing problems in current practice, because a lot of effort is wasted in determining whether a failure is really due to a bug, or is only due to flakiness. We conjectured that the source codes of flaky tests share similar traits and applying this idea we have been able to statically predict flakiness with precision values higher than 85%. Facebook Research launched an open competition calling for ideas for tackling the flaky test problem, and our proposal was one of the ten selected from among more than 100 submissions.

Another important research direction for reducing testing costs is test automation. The SEDC lab is a member of the H2020 European consortium that is developing the ElasTest Open-Source platform. The ElasTest project aims at supporting end-to-end testing of complex distributed systems. End-to-end is the last stage of software integration testing and involves the testing of

the whole system from the user interface all the way through to the system outputs. The final version of this platform is due by end of 2019; it improves test observability, reduces testing times, and facilitates non-functional tests, including those regarding security and Quality-of-Experience. In brief it offers an all-in-one and extensible solution for automation of testing in the Cloud. Everyone involved in software development is invited to join the ElasTest community as a user, a contributor or even a developer, see <https://elastest.io/>.

In conclusion, it is evident that software testing is an extremely important area for both research and practice and promises to provide us with many exciting challenges in the future.

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Visual representation of FAST-R preparation phase

Open science for blue growth

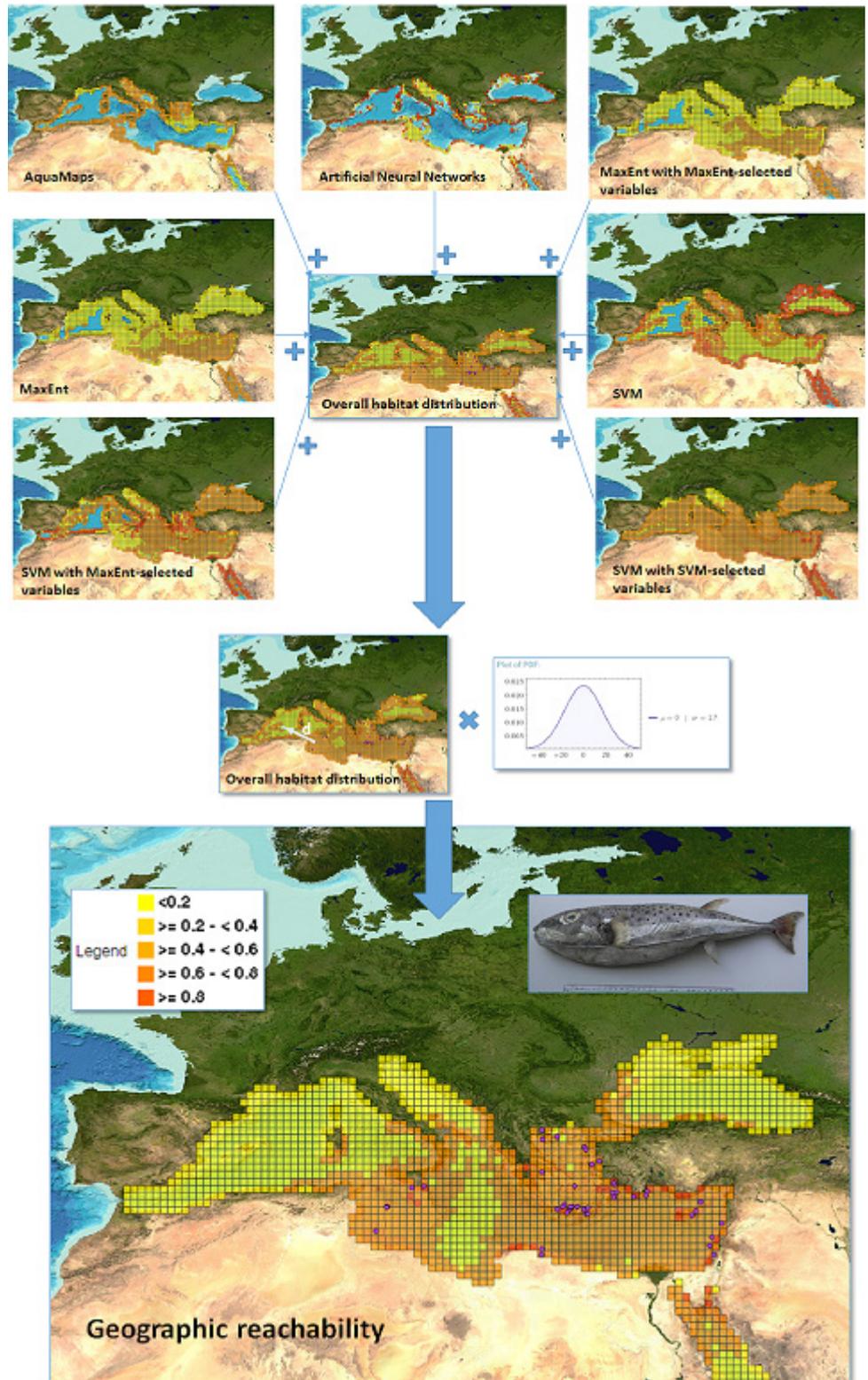
Connecting Science, Big Data, and Artificial Intelligence to sustain, contribute, and accelerate a conscious and sustainable exploitation of the seas and of the marine resources

[continued]

These problems also require strong collaboration among experts with different disciplinary competences, e.g. AI experts needs to collaborate with marine science biologist to deal with large amount of data.

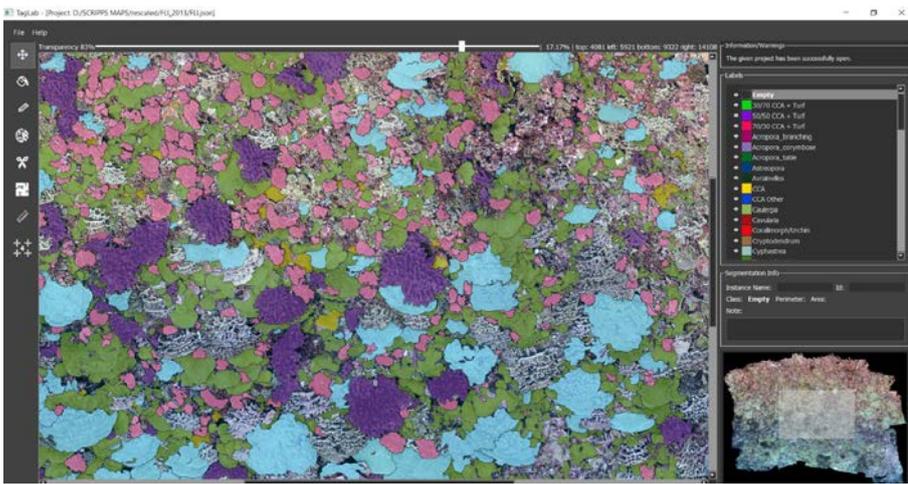
ISTI developed competencies in Environmental Science and Ecological monitoring that proved to be valuable for solving Blue Growth problems. In particular, Ecological monitoring allows analyzing the current condition and the persisting trends of marine habitats, to quantify the impacts of bounded and extensive events, to asses the resilience of animal and plant species, etc.

In this contest, the InfraScience group of the NeMIS ISTI laboratory developed solutions for a number of important problems. The first problem is the estimate of the sustainable fish catch, i.e. the maximum quantity of fish that can be taken from a population in a certain area of the sea so that this population reproduces of that quantity in the next year. InfraScience contributed to build a suite of Bayesian methods for this problem (CMSY), which is currently the most used worldwide by ministries (e.g. Italian, Japan) and advisory entities (e.g. University of British Columbia, NOAA, and others). This suite is also available through a Web interface on the D4Science¹ e-Infrastructure - the data infrastructure operated by ISTI to promote Open Science - to courses for European University students and scientists from developing countries. In other experiments within EU multi-disciplinary teams, InfraScience used D4Science to build AI models that predict the presence of a species in a certain area by estimating the “preferences” of the species to certain environmental characteristics. Thanks to the re-usability



Combining several models to estimate the invasion of an alien species

1 D4Science: www.d4science.org



TagLab annotation tool: a labeled coral reef map

of models and data enabled by D4Science, InfraScience re-used species models also to estimate intensive fishing locations from GPS data of fishing vessels. The detected patterns of fishing activities, for example in the Indian Ocean, were forecasted in the future to prevent future fishing overexploitation and piracy. In other experiments, InfraScience used the D4Science cloud computing platform (DataMiner) to project climatic environmental parameters in the future, under different greenhouse gases emission hypotheses. This allowed estimating the effects of Climate Change on marine species distributions and on the fisheries industry. These experiments also highlighted the higher resilience of the Mediterranean Sea to Climate Change with respect to other seas. On the other hand, AI models showed up that this resilience also fosters the proliferation of alien and invasive species arriving in the Mediterranean Sea through the Suez Canal, for example the highly toxic and voracious silver-cheeked toadfish that is causing losses for million euros per year in the western Mediterranean Sea.

These results were obtained in short time thanks to the fast combination of models, data, and competences guaranteed by the Open Science services of D4Science, which also allowed re-using the models in completely new domains with respect to their original meant ones. For example, IGG used species distribution models to estimate the suitability of a certain area to the installation of a geothermal plant, and the Cranfield University re-used models developed for

marine science to build up models for river ecosystems.

Ecological monitoring can also use underwater imaging technologies as a powerful solution to support repeatable surveys on a large scale while maintaining a high level of accuracy required by biological investigations. Video and image sequences are a trustworthy source of knowledge that often remains unexploited. A recent study reported that just 1-2% of the millions of underwater images acquired each year on coral reefs by the National Oceanic and Atmosphere Administration (NOAA) are later analysed by experts. The human image analysis is a time-consuming task that creates a bottleneck between data collection and extraction.

Automatic extraction of information from these data allows exploiting a large scale visual survey potential. For example, for benthic species this automated analysis can cover full species detection range and can help solving the image semantic segmentation problem. Nowadays, this task can be efficiently performed using Deep Learning-based methodologies. However, even if fully automated semantic segmentation can significantly reduce image processing time, current solutions have much lower accuracy than human experts.

Besides, the automation of such specific processes requires proper tools to prepare the data and validate the results.

In 2019, the ISTI Visual Computing Lab developed a human-in-the-loop approach for the automatic analysis of benthic communities. This AI-powered annotation tool (TagLab), currently supports two of the most significant coral reef investigation projects: the 100 Island Challenge² headed by the Scripps Institution of Oceanography (UC, SAN DIEGO) and the Moorea Island Digital Ecosystem Avatar³.

In 2020, the Visual Computing Lab will join the Piano nazionale di ricerca in Antartide with the project “Ross Sea Benthic Monitoring Program: new non-destructive and machine-learning approaches for the analysis of benthos patterns and dynamics”.

Thanks to the scientific results achieved on marine science, FAO and ISTI have officially agreed – through the signing of a Memorandum of Understanding - to intensify their collaboration in iMarine⁴, the cloud-based community platform powered by the D4Science Infrastructure to help improving fisheries management. Using the D4Science infrastructure, iMarine will promote integrated access to data, and will simplify their management, while reducing costs and time for integrating and accessing these data.

Thanks to the agreement, FAO’s extensive knowledge of fisheries will therefore be further integrated and made accessible through the iMarine portal and will be used for research and data development programs in developing countries to improve food availability worldwide.

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<https://www.d4science.org>

² <http://100islandchallenge.org>

³ <https://bids.berkeley.edu/research/moorea-island-digital-ecosystem-avatar-moorea-idea>

⁴ iMarine: <https://i-marine.d4science.org>

ERC AdG XAI: science and technology for the eXplanation of AI decision making

Co-funded by European Research Council - ERC

The XAI project, funded by an ERC Advanced Grant awarded to Fosca Giannotti, focuses on the urgent open challenge of how to construct meaningful explanations of opaque AI/ML systems, introducing the local-to-global framework for black box explanation, articulated along three lines: (1) the language for expressing explanations in terms of expressive logic rules, with statistical and causal interpretation; (2) the inference of local explanations for revealing the decision rationale for a specific case, by auditing the black box in the vicinity of the target instance; (3), the bottom-up generalization of many local explanations into simple global ones, with algorithms that optimize for quality and comprehensibility. An intertwined line of research will investigate (1) causal explanations, i.e., models that

capture the causal relationships among the (endogenous and exogenous) variables and the decision, and (2) mechanistic/physical models that capture the detailed data generation behavior behind specific deep learning models, by means of the tools of statistical physics of complex systems.

Together with the development of the models and algorithms for explanation, the XAI project will also develop: (1) an explanation infrastructure for the benchmarking of the methods developed within and outside this project, equipped with platforms for the users' assessment of the explanations and the crowdsourcing of observational decision data; (2) an ethical-legal framework, both for compliance and impact of the methods developed on current legal standards; and (3)



a repertoire of case studies in explanation-by-design, with a priority in health and fraud detection applications.

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<https://kdd.isti.cnr.it/project/science-and-technology-explanation-ai-decision-making>

ARIADNEplus

Advanced Research Infrastructure for Archaeological Data Networking in Europe – plus
Co-funded by Horizon 2020

ARIADNEplus is the continuation of the successful ARIADNE project (2013-2017) for the integration of European archaeological repositories, which created a searchable catalogue of datasets including unpublished reports, images, maps, databases and other kinds of archaeological information accessible online.

The 41 ARIADNEplus partners come from 23 European countries and 4 extra-European partners. ARIADNEplus is funded to support researchers; but we believe it may be important and useful also for heritage agencies and managers.

At present, about two million datasets have been catalogued, corresponding to a huge volume of information as each dataset may comprise, for example, an entire report with



related images, drawings, or a complete database including thousands of individual records.

The catalogued content types range from individual finds to monuments and sites inventories, from the report of a single intervention to the results of a long-term archaeological mission. ARIADNEplus will update existing data in the ARIADNE Portal, extend ARIADNE in geographic and temporal coverage, and in the range of topics addressed, now incorporating additional information about scientific analyses. It will also provide services to further process and re-use those data.

Although most of the technology employed in ARIADNEplus concerns the data integration goals of the project, including the creation of a searchable catalogue and the development of a Linked Open Data approach, a key role is played by the data services which the project will make available. These range from tools for data analysis (e.g. for data mining and Natural Language Processing) and for data synthesis, (e.g. visualization of images and 3D, locating data on a map or in time, browsing the data using Linked Open Data, and so on). ISTI-CNR is the main IT research partner in ARIADNEplus, with a major role in the provision of the project platform and tools.

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Blue Cloud

Piloting innovative services for Marine Research & the Blue Economy Co-funded by Horizon 2020

Blue-Cloud implements a practical approach addressing the potential of cloud-based open science. The objective is to build a thematic European Open Science Cloud (EOSC) offering a set of services to manage key aspects of ocean sustainability, through a set of five pilot Blue-Cloud demonstrators. The activity seeks to capitalise on what already exists and to develop and deploy the pilot Blue Cloud as a cyber platform providing access to: 1) multidisciplinary data from observations and models, 2) analytical tools, & 3) computing facilities for key blue science use cases. Outputs of the activity will include: the Blue Cloud Framework, a Data Discovery & Access Service (approx. 400 users) & a

VRE – Virtual Research Environment (approx. 1,000 users) from 25 countries, a Blue Cloud Service Catalogue including 50+ services deployed through 5 pilot demonstrators, a Blue Cloud 2030 Implementation Policy Roadmap, a whitepaper discussing the outcomes of the Food/Blue-Cloud Pilots supporting the implementation of a thematic EOSC, 4 focused Roadmap events & Workshops, 1 hackathon, 10 webinars, 1 Final conference presenting the results, an engaged community with all stakeholder groups represented.

Blue Cloud is led by a consortium which brings together leading European marine data management infrastructures, EOSC

horizontal e-infrastructures, and key marine researchers. The project is managed by a neutral ICT intensive SME and technically coordinated by a community of leading marine & ocean data specialists supported by 17 experienced partners from research, academia & industry, strongly involved in design and delivery of blue community needs. An influential External Stakeholders Expert Board & an Expert Foresight Group also support the project.

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DESIRA

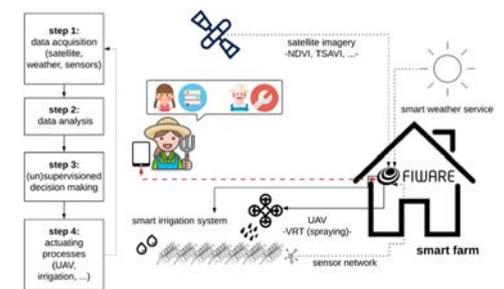
Digitisation: Economic and Social Impacts in Rural Areas Co-funded by EU Horizon 2020

DESIRA will develop the concept of Socio-Cyber-Physical Systems to advance the understanding of the impact of digitisation in rural areas, linking the analysis directly to the United Nation's Sustainable Development Goals.

Operationalising the Responsible Research and Innovation approach, DESIRA will enroll agriculture, forestry and rural stakeholders in co-developing scenarios and policies in Living Labs established in 20 European Regions, and a Rural Digitization Forum gathering 250 stakeholders from all Europe. A Virtual Research Environment, tailored to the purposes of the project, will connect all participants and will fuel the interaction within the network. DESIRA will provide a Taxonomy and Inventory of Digital Game Changers, which will be available online in a visualization tool; a set of socio-economic impact indicators aligned to the Sustainability Development

Goals implemented into an online socio-economic impact tool; a pan-European assessment of digitization in European rural regions; a needs, expectations and impact appraisal report; a comparative scenario report based on scenario development activities of 20 European Living Labs and of the Rural Digitization Forum; a policy analysis and roadmap; an ethical code to be adopted by researchers and innovators and recommended by policy bodies; five ICT use cases - co-created by Living Labs with the support of ICT specialists - of the most promising solutions identified by Living Labs; showcase technologies - including a Virtual Farm platform - that will create a set of ICT-ready proof of concepts to be used in agriculture, forestry, and rural areas.

A detailed, multi-media dissemination, engagement and communication strategy will accompany the project from the beginning, looking at research as a multifunctional (re-

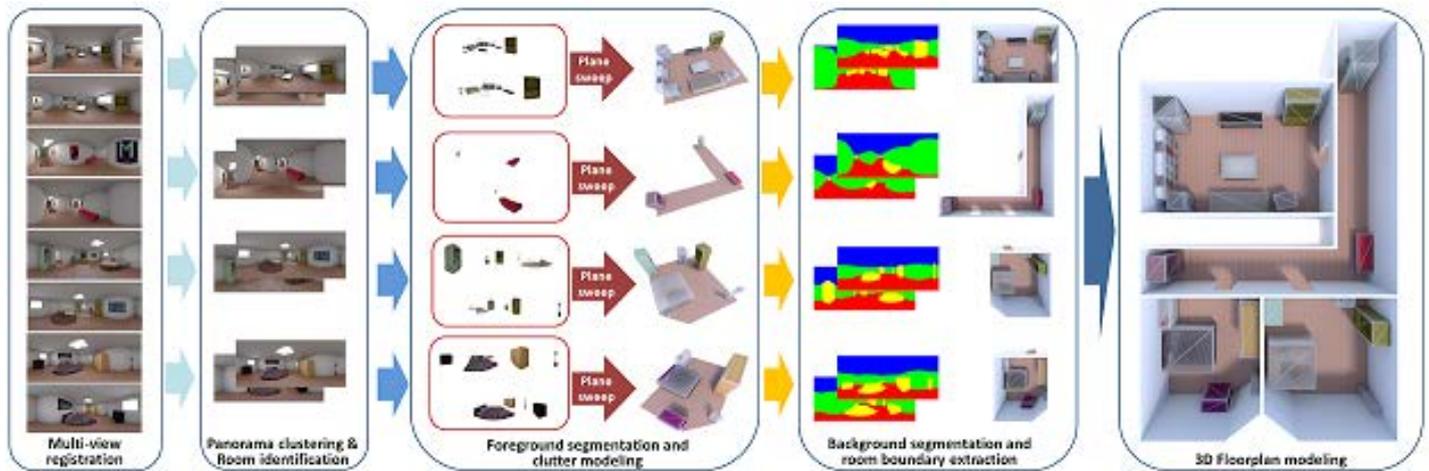


search, engagement and communication) process and at the same time involving communication specialists in the development of adequate messages and in the choice of the most effective media.

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ENCORE

ENergy aware BIM Cloud Platform in a COst-effective Building RENovation Context
Co-funded by Horizon 2020



The stock of residential buildings in the EU is growing old rapidly, with more than 40% built before 1960, and 90% before 1990. One of the main drawbacks of older buildings is their higher energy consumption and consequent negative impact on our lives, both from an economic and environmental point of view. Thus, increasing the share of renovated stock worldwide has become an ineludible challenge.

In this context, the ENCORE project proposes a system to assist the entire life-cycle of a building renovation process. The system will revolve around the Building Information Model (BIM) concept, a recent de-facto

standard that provides a digital detailed representation of a building, both physical and functional, over time. ENCORE is pursuing several specific objectives: (a) the design of general Building Energy Efficiency and Comfort models that observe the climatological diversity of European countries and their regulations; (b) the proposal of an ontology that identifies the entities of a building, their properties and their relations; (c) the development of an acquisition service that allows the creation of a BIM model from the acquisition of real world data; (d) the simulation of the entire renovation process.

In the framework of ENCORE, ISTI-CNR is

committed to developing new algorithms for the acquisition of the shape and appearance of buildings. For the indoor component, it has proposed an image-based technique that allows the reconstruction of entire floors using a few panoramic images per room (see the pipeline in the figure below). For the exterior component, it is studying algorithms for optimizing the use of video streams for 3D reconstruction.

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EOSC-Pillar

Coordination and harmonisation of National initiatives, infrastructures and data services in central and western Europe Co-Funded by Horizon 2020

EOSC-Pillar gathers representatives of the fast-growing national initiatives for coordinating data infrastructures and services in Italy, France, Germany, Austria and Belgium to establish an agile and efficient federation model for open science services covering the full spectrum of European research communities. Our proposal aims to implement some of the main pieces of the EOSC jigsaw within a science-driven approach which is efficient, scalable and sustainable and that can be rolled out in other countries. National initiatives are the key of our strategy, for their capacity to attract and coordinate many elements of the complex EOSC ecosystem and for their sustainability, which will add resilience to the whole structure. We will combine these initiatives, which represent research communities in each country, with use cases of transnational networks working to imple-

ment FAIR data practices. Through the coordination of national initiatives, EOSC-Pillar will be able to support the gradual alignment of policy and practice among countries and compliance to EOSC standards. We are convinced that by federating national initiatives through common policies, FAIR services, shared standards, and technical choices, EOSC-Pillar will be a catalyst for science-driven transnational open data and open science services offered through the EOSC portal. These initiatives will emanate the promotion of FAIR data practices and services across scientific communities, sharing best practices, and igniting opportunities for interdisciplinary approaches in the EOSC. Above all, our vision is that national initiatives are key to involve user communities and research infrastructures, both as testbeds for solutions but also in their very de-



sign and sustainable evolution. For this reason, EOSC-Pillar's workplan is built around selected user-driven pilots from 7 scientific domains, that will show EOSC in action and provide valuable input to guide the roll-out of services for other communities.

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RISIS2

European research infrastructure for science, technology and innovation policy studies 2 Co-funded by Horizon 2020

The European Research Infrastructure for Science, Technology and Innovation policy studies (RISIS2) aims at building a data and services infrastructure supporting the development of a new generation of analyses and indicators. To develop a deeper understanding of knowledge dynamics and policy relevant evidence, the project goes beyond established quantitative indicators, developing positioning indicators, which take into account critical features of knowledge dynamics i.e. the importance of asymmetries in producers, in places and in themes. RISIS datasets are built keeping information in these three dimensions. New services dealing with actor identification, geographical information and thematic foci have been developed, as well as semantic analytical capabilities.

This project builds on RISIS1 (2014-18), which demonstrated the relevance of such an approach and opened access to a first set of databases and services. RISIS2 involves 19 partners and aims at transforming the field of STI (Science, Technology and Innovation) studies into an advanced research community. This significant change is achieved by: (i) developing an e-infrastructure that supports full virtual transnational access by researchers, (ii) providing a vastly enlarged set of services tailored to field-specific needs (for problem-based integration of datasets, for exploring open data, and for supporting analytical capabilities of researchers), (iii) maintaining datasets dealing with firm innovation capacities, public research developments,

R&I (Research & Innovation) outputs and projects, and policy learning, (iv) developing new datasets on four key issues for research and policy (social innovation, non-technological innovation, the role of PhDs in society, portfolios of public funding instruments). As reflected in the strong role of OpenAIRE in RISIS2, the infrastructure is fully inscribed into the Open Science movement. It is accompanied by a strong training, dissemination and communication effort to support the important widening of the community involved.

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OK-INSAID

Operational Knowledge from Insights and Analytics on Industrial Data Co-funded by the National Operational Program on Research and Innovation



OK-INSAID (MIUR-PON, 2018-2021) aims to attain scientific and technological innovation thanks to the introduction of Big Data Analytics in the industrial sector. The final goal is to help redesign production processes and business models toward the Industry 4.0 vision. OK-INSAID aims to achieve this innovation by defining new data driven methods for industrial applications and a new approach to these applications based on coordination, synchronization, and collaboration among analytics in cloud and at the edge.

OK-INSAID contributes to this scenario by fostering the diffusion and field testing of an integrated and modular platform for the construction of innovative services and solutions based on Big Data Analytics for In-

dustry 4.0. This platform provides a reference framework for the construction of new solutions and for facilitating the adoption of these solutions through new business models and adoption plans.

The activities of OK-INSAID are focused on five macro-areas of industrial research and experimental development: 1) the definition of new models and methods for gathering and storing industrial data from heterogeneous sources with the final goal of creating an industrial data space at the enterprise level, 2) the investigation of new algorithms and data science methods aimed at generating added value from the data made available, 3) new industrial analytics which, by exploiting the distributed data processing

model, allow innovation on the reference production process, 4) the investigation of new methods for the security of the data collected, 5) the investigation of new methodologies and techniques for visualizing the results obtained to provide users with ideas, value and operational knowledge on wearable devices, personal mobile devices and augmented/virtual reality. All the above activities will be tested and validated in the real-world environments and facilities provided by three industrial partners: AVIO, SACMI, CRF/FCA.

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EOSCsecretariat.eu

Co-Funded by Horizon 2020

EOSCsecretariat.eu addresses the need for the set-up of an operational framework supporting the overall Governance of the EOSC. Led by a lean consortium of experienced and complementary partners, the project maintains a practical approach to address all the specific needs of the coordination structure expected by the EOSC

The project will adopt a Co-creation approach working with the community to deliver many of the activities and has reserved a substantial portion of the budget for organisations not in the consortium. This approach will enable a high degree of flexibility in order to address any foreseen or unforeseen challenges that may arise during the project.

EOSCsecretariat.eu is characterised by being neutral towards the community it is serving and by having a pragmatic approach that is fully dedicated to realising the outcomes of the EOSC design as stated in the Implementation Roadmap Staff Working Document and adopted Council Conclusions in order to deliver an operational open

science cloud for all European stakeholders. The outputs of EOSCsecretariat.eu include: Secretariat organisational structure, processes & procedures, rules & legal framework; business models; press & media office; pan-European awareness increase; open consultation; knowledge base; coordination services to WGs; coordination with EOSC-related projects; organisation & support to boards & events; two Stakeholders Forums; liaison with non-EU countries; a community engaged with all stakeholder groups represented.

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EMPATHY

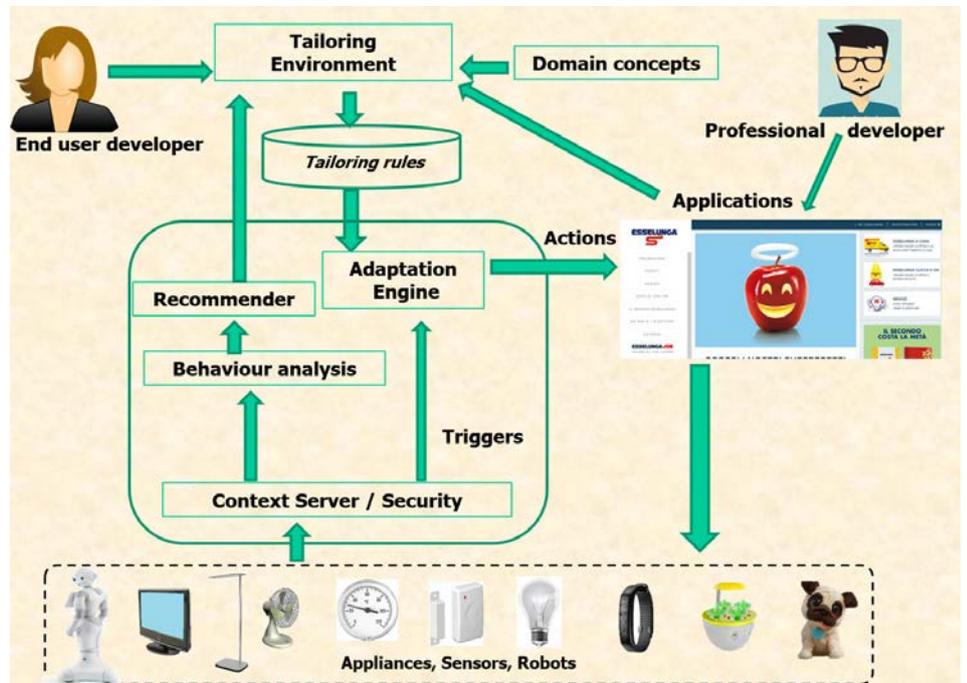
Empowering People in Dealing with Internet of Things Ecosystems Co-funded by Projects of National Interest (Progetti di Ricerca di Interesse Nazionale – PRIN)

The fundamental challenge addressed in this project is the empowering of end users to configure smart environments able to exploit up to hundreds or thousands of interconnected devices and objects, which will enable many possible interactions in a user's surrounding. The goal is to allow users to control smart IoT applications rather than be driven by them.

The project aims at developing new concepts, languages, methods, and tools to support people in creating and tailoring IoT context-dependent interactive applications for their needs. Security and privacy issues will also be addressed. The project will also focus on how to support end user developers to easily identify and fix errors that they might have unintentionally introduced in their applications. The theoretical contribution of EMPATHY will be to guide the design of a platform to support domain experts in tailoring context-dependent IoT applications and adapt them as needed for specific activities.

The project aims at achieving these main results:

- a set of abstractions, languages, and methods to support both domain experts and end users in creating and tailoring IoT context-dependent interactive applications for their needs through a meta-design approach;



- a platform offering: 1) a tailoring environment for domain experts, which provides novel interaction metaphors and multimodal interfaces to specify context-dependent applications through the trigger/action paradigm; 2) a middleware to identify dynamic sets of people, objects, services, associated events, and secure communication between them, also analysing actual usage to infer further adaptation and evolution strategies; 3) design and runtime support for dynamic context-dependent adaptation of IoT applications;
- validation in three relevant IoT application domains (ambient assisted living, education and learning, cultural heritage) in order to show the generality of the approach;
- empirical user experience evaluation in the wild for both non-professional development activities and actual user experience, also performing emotion recognition based on biofeedback.

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IT MaTTeRS

Methods and Tools for Trustworthy Smart Systems

Co-funded by Projects of National Interest (Progetti di Ricerca di Interesse Nazionale – PRIN)

Smart systems are large-scale, physically-distributed services where different kinds of data-collection sensors are used to supply information employed to efficiently manage assets and resources, and provide efficient operations. These systems are increasingly pervasive and interact extensively with their environment. It is thus crucial that unexpected and possibly dangerous situations be avoided. Hence, there is a strong need for techniques to guarantee that systems are trustworthy. Here trustworthiness is a holistic property, encompassing different characteristics (such as safety, security, integrity, availability, correctness, reliability and resilience) that are not addressed in isolation but as a whole at system level.

The goal of the IT MaTTeRS project is the development and experimentation of a novel methodology for the specification, implementation and validation of trustworthy smart systems based on formal methods. The project envisages system development in three steps by first providing and analysing system models to find design errors, then moving from models to executable code by translation into domain-specific programming languages and, finally, monitoring runtime execution to detect anomalous behaviour and to support systems in taking context-dependent decisions autonomously.

The ambitious 3-year project is coordinated by Rocco De Nicola from IMT Lucca, while

Maurice ter Beek from ISTI-CNR coordinates the workpackage on Application and Validation, which will demonstrate the feasibility and impact of the various techniques, methodologies and tools developed during the project by applying them to three challenging smart-system scenarios of direct importance to some of the project partners and related stakeholders. Additional partners are the Gran Sasso Science Institute and the Universities of Camerino, Pisa and Udine.

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COVR

Being safe around collaborative and versatile robots in shared spaces

Co-funded by Horizon 2020

COVR is driven by five national research and technology organisations. Through the development of an intuitive toolkit and a range of testing protocols for validation of safety for cobots, COVR will increase the safety of all types of collaborative robots across all domains. COVR is working to offer a free toolkit for coboteers to determine how to test and validate safety for their collaborative robot application or component.

COVR's mission is to increase safety for all robots sharing space with humans by applying skill-based testing across robot domains. Increasing safety for collaborative robots enables new innovative applications, thus increasing production and job creation for companies utilizing the technology.

COVR will offer coboteers the possibility to apply for a COVR Award of up to 60.000€, to test the safety testing services offered by COVR; either alone or in a consortium with other coboteers.

COVR is driven by Danish Technological Institute (DTI), Roessingh Research and Development (RRD), The French Alternative Energies and Atomic Energy Commission (CEA), Fraunhofer Institute for Factory Operation and Automation (IFF) and The National Research Council (CNR).

COVR works with all companies in the cobot value chain. From robot and components manufacturers over system integrators to end-users to provide value and safety in all stages of cobot adaption. Whether you're



an established company seeking to deploy cobots or an innovative startup with a prototype of a cobot related product, COVR will help you analyze, test and validate the safety for that application.

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<http://safearoundrobots.com/getcovr>

CYBERSEC4EUROPE

Cyber Security Network of Competence Centres for Europe Co-funded by Horizon 2020

CyberSec4Europe is a research-based consortium with 43 participants from 22 EU Member States and Associated Countries. As a pilot for a Cybersecurity Competence Network, it will test and demonstrate potential governance structures for the network of competence centers using the best practice examples from the expertise and experience of the participants, including concepts like CERN.

CyberSec4Europe will address key EU Directives and Regulations, such as the GDPR, PSD2, eIDAS, and ePrivacy, and help to implement the EU Cybersecurity Act including,

but not limited to supporting the development of the European skills base, the certification framework and the role of ENISA.

CyberSec4Europe partners address 14 key cybersecurity domains, 11 technology/ application elements, and nine crucial vertical sectors. With participation in over 100 cybersecurity projects amongst them, CyberSec4Europe partners have considerable experience addressing a comprehensive set of issues across the cybersecurity domain. The project demonstration cases will address cybersecurity challenges within the vertical sectors of digital infrastructure, finance,



**Cyber
Security
for Europe**

government and smart cities, health and medicine and transportation. In addition to the demonstration of the governance structure and the operation of the network, CyberSec4Europe will develop a roadmap and recommendations for the implementation of the Network of Competence Centres using the practical experience gained in the project.

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Humane AI

New Ethical, Trustworthy, AI Technologies to Enhance Human Capabilities and Empower European Citizens and Society. Coordination Horizon 2020

Over the course of the last decade, artificial intelligence (AI) researchers have made ground-breaking progress in hard and long-standing problems related to machine learning, computer vision, speech recognition and autonomous systems. In combination with continuing advances in related technologies such as Internet of Things (IoT), mobile computing and mechatronics, AI is quickly becoming an integral part of nearly all areas of our daily lives, from smartphones and smart watches to personal digital assistants such as Amazon Echo and Google Home to autonomous vehicles, smart cities, Industry 4.0 and beyond. AI and the subtopic of machine learning are also increasingly becoming indispensable tools of scientific discovery. By packaging AI functionality in cloud services and libraries, the hurdle for using AI technologies has been lowered, pushing forward a wealth of innovative applications in many different domains. As impressive as these developments are, and as much as these technologies have already changed our lives, there is a general agreement that what we see today is just



the beginning of an AI revolution. There is also a strong consensus that AI will bring forth changes that will be far more profound than any other technological revolution in human history. Depending on the course that this revolution takes, AI will either empower our ability to make more informed choices or reduce human autonomy; expand the human experience or replace it; create new forms of human activity or make existing jobs redundant; help distribute well-being for many or increase the concentration of power and wealth in the hands of a few; expand democracy in our societies or put it in danger. Europe carries the responsibility of shaping the AI revolution. The choices we face today are related to fundamental ethical issues about the impact of AI on society, in particular, how it affects labour, social interactions, healthcare, privacy, fairness and security. The ability to make the right choices requires new solutions to fundamental scientific questions in AI.

The Humane AI project will develop the scientific foundations and technological breakthroughs needed to shape the AI revolution in a direction that is beneficial to humans on both individual and societal level and that adheres to European ethical values and social and cultural norms. The core challenge is the development of AI systems capable of what could be described as “understanding” humans, adapting to complex real world environments and appropriately interacting in complex social settings. The aim is to enhance human capabilities and to empower people as individuals and at the level of the society as whole. The HumanE AI project will bring about the mobilization of a research landscape far beyond the direct project funding and create a unique innovation ecosystem that will provide a manifold return on investment for European economy and society.

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<https://www.humane-ai.eu/>

PETAL

PErsonalizable assIstive Ambient monitoring and Lighting Co-funded by the EC within the Active and Assisted Living Programme - ICT for ageing well.

PETAL is an international AAL project involving six partners and coordinated by the HIIS laboratory where we are designing and developing a platform for the personalization of remote assistance for older adults with Mild Cognitive Impairments. Particular attention is being given to the support of lighting systems in order to provide orientation over time and in space. This category of users suffers from cognitive issues, such as the tendency to forget tasks and events, or other issues such as cardiovascular issues, reduced sight, irregular eating habits, often associated with an increased risk of social isolation and depression. The platform aims to support the monitoring the user's environment and behaviour, as well as personalizing applications for cognitive stimulation and controlling devices to better support seniors in their daily life. It thus exploits smart objects such as lights to provide support in terms of activation or relaxation

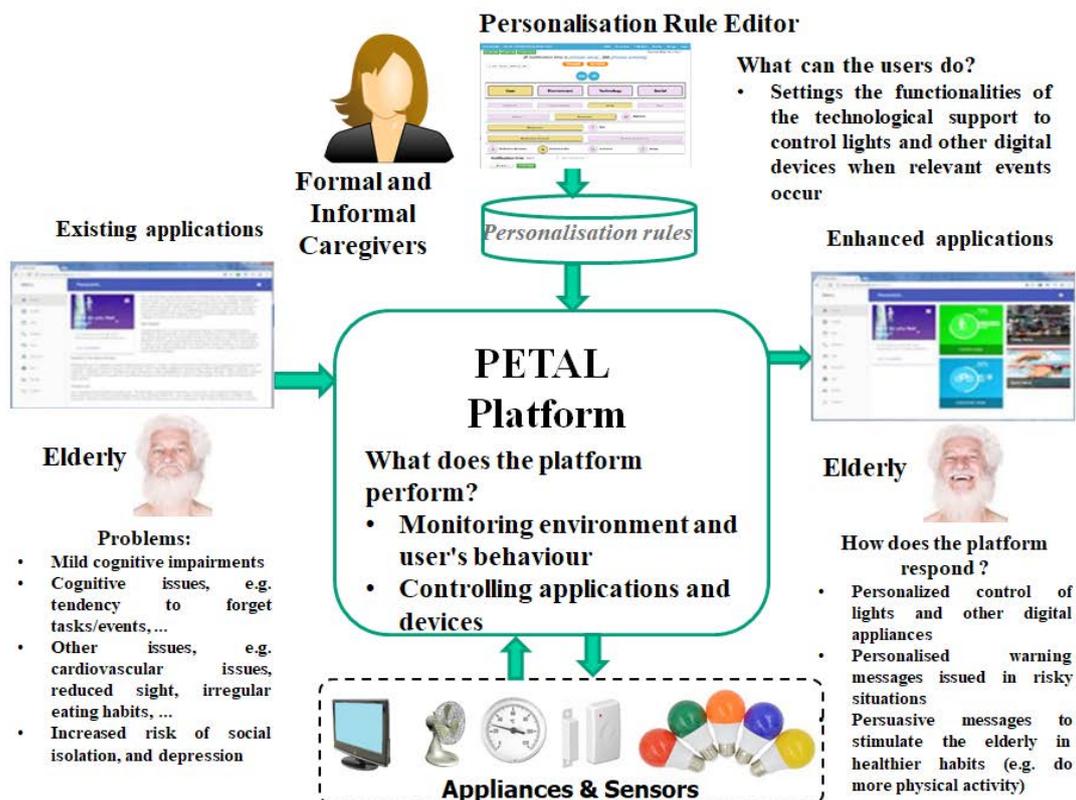
stimuli, generation of alerts and reminders for physical and social activities, orientation over time and space.

The user or caregiver can set the device to control lights and other digital devices when relevant events occur. In this way it is possible to personalise control of the lights and other digital appliances, to set personalised warning messages to be issued in situations of risk, and persuasive messages to encourage healthier habits (e.g., more physical activity). The possible personalisations are expressed in terms of simple trigger-action rules. Triggers represent situations or events that might be useful for caregivers to know: e.g. health/cognitive/emotional status, cognitive/physical/social activity, especially when the caregiver is not present (remote monitoring). The information associated with triggers is derived from various sensors (e.g. motion, proximity, lights, noise, respi-

ration, heart). Actions represent what the technological equipment within the home could do: control appliances (e.g. switch on/off lights, close/open doors, play tv/radio), send reminders, send alarms, provide information about the user's needs.

The platform has been deployed with various associated sensors and appliances in six trials between May 2019 and September 2019 in Roma, Bolzano and Bucharest in homes of mildly cognitive impaired older adults. In the trials, 164 rules were created by caregivers together with the older adults and were triggered 15224 times. These rules mainly concerned controlling the light, and generating reminders or alarms.

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TCP-based M2M traffic via random-access satellite links: throughput estimation

M. Bacco, T. De Cola, G. Giambene, A. Gotta
 IEEE Transactions on Aerospace and Electronic Systems, vol. 55. IEEE, 2019.

Provisioning of Internet of Things/machine-to-machine (M2M) services over satellite has been experiencing a continuous growth in the last few years, which is expected to further increase in the near future so as to meet the demands of users and enterprises. The design of a suitable network architecture is, hence, of paramount importance to properly take into account the requirements imposed by the technology available nowadays and to properly consider the in-

teraction of the so-defined physical layer with transport and application layers. In this light, this paper analyzes the use case of TCP-based M2M services operating over DVB-RCS2 satellite links, where a contention resolution diversity slotted ALOHA access scheme is applied. The main goal of this paper is to provide a thorough understanding of the interactions of TCP and random access schemes, recognized as key elements to enable efficient M2M services over satel-

lite. In this regard, this paper also develops a novel TCP throughput model, which has been validated through extensive simulation campaigns, proving the value of the proposed theoretical framework and its applicability to study the performance of M2M services in more general satellite scenarios.

DOI: 10.3390/s19143238

IoT-based home monitoring: supporting practitioners' assessment by behavioral analysis

N. Mora, F. Grossi, D. Russo, P. Barsocchi, R. Hu, T. Brunschwiler, B. Michel, F. Cocchi, E. Montanari, S. Nunziata, G. Matrella, P. Ciampolini
 Sensors (Basel), vol. 19. MDPI, 2019.

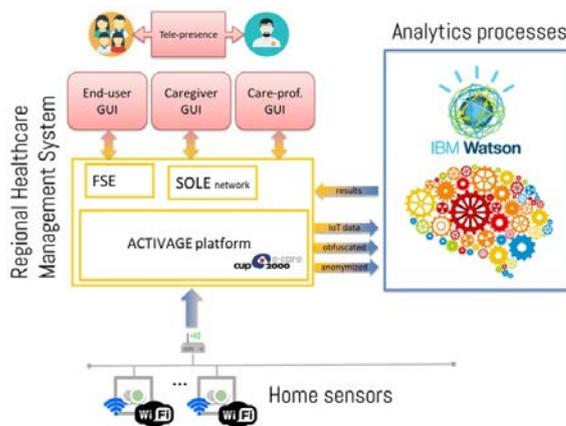


Diagram of the ACTIVAGE DS-RER system architecture, interacting with the FSE (FascicoloSanitario Elettronico, the patients' interface to regional Electronics Health Record system) and the SOLE network (the interface for clinicians)

This paper introduces technical solutions devised to support the Deployment Site - Regione Emilia Romagna (DS-RER) of the ACTIVAGE project. The ACTIVAGE project aims at promoting IoT (Internet of Things)-based solutions for Active and Healthy ageing. DS-RER focuses on improving continuity of care for older adults (65+) suffering from aftereffects of a stroke event.

A Wireless Sensor Kit based on Wi-Fi connectivity was suitably engineered and realized to monitor behavioral aspects, possibly relevant to health and wellbeing assessment. This includes bed/rests patterns, toilet usage, room presence and many others. Besides hardware design and validation, cloud-based analytics services are introduced, suitable for automatic extraction of

relevant information (trends and anomalies) from raw sensor data streams. The approach is general and applicable to a wider range of use cases; however, for readability's sake, two simple cases are analyzed, related to bed and toilet usage patterns. In particular, a regression framework is introduced, suitable for detecting trends (long and short-term) and labeling anomalies. A methodology for assessing multi-modal daily behavioral profiles is introduced, based on unsupervised clustering techniques. The proposed framework has been successfully deployed at several real-users' homes, allowing for its functional validation. Clinical effectiveness will be assessed instead through a Randomized Control Trial study, currently being carried out.

DOI: 10.3390/s19143238

Teaching requirements elicitation interviews: an empirical study of learning from mistakes

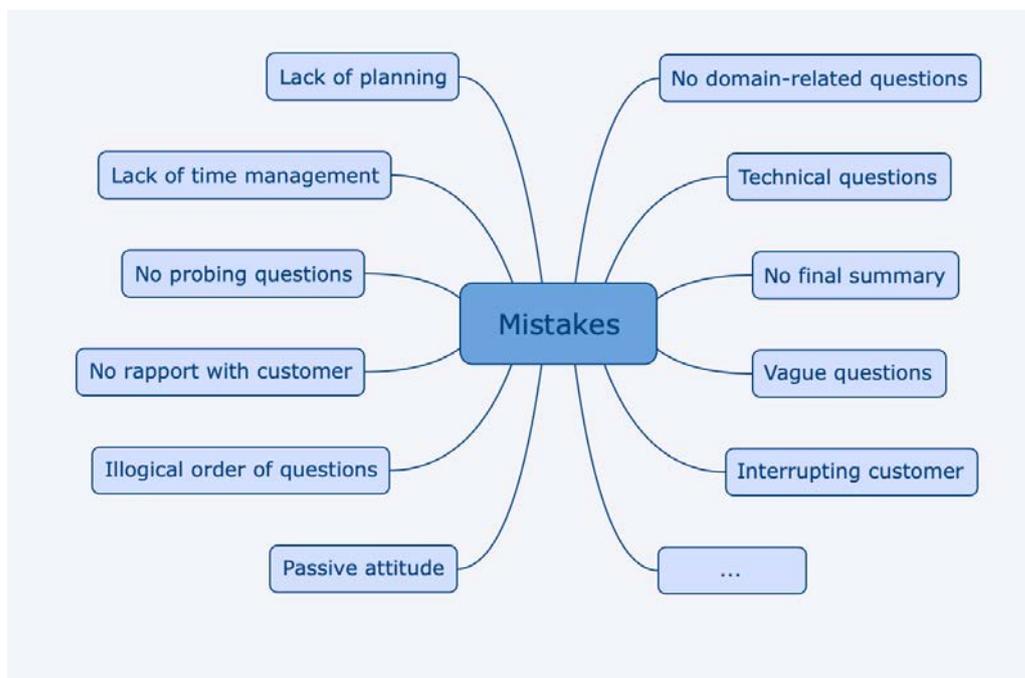
M. Bano, D. Zowghi, A. Ferrari, P. Spoletini, B. Donati
Requirements Engineering, vol. 24. Springer, 2019.

Interviews are the most widely used elicitation technique in requirements engineering (RE). However, conducting a requirements elicitation interview is challenging. The mistakes made in design or conduct of the interviews can create problems in the later stages of requirements analysis. Empirical evidence about effective pedagogical approaches for training novices on conducting requirements elicitation interviews is scarce. In this paper, we present a novel pedagogical approach for training student analysts in the art of elicitation interviews. Our study is conducted in two parts: first, we perform an observational study of interviews performed by novices, and we present a classification of the most common mistakes made; second, we utilize this list of mistakes and monitor the students' progress in three

set of interviews to discover the individual areas for improvement. We conducted an empirical study involving role-playing and authentic assessment in two semesters on two different cohorts of students. In the first semester, we had 110 students, teamed up in 28 groups, to conduct three interviews with stakeholders. We qualitatively analysed the data to identify and classify the mistakes made from their first interview only. In the second semester, we had 138 students in 34 groups and we monitored and analysed their progress in all three interviews by utilizing the list of mistakes from the first study. First, we identified 34 unique mistakes classified into seven high-level themes, namely question formulation, question omission, interview order, communication skills, analyst behaviour, customer interaction, teamwork

and planning. In the second study, we discovered that the students struggled mostly in the areas of question formulation, question omission and interview order and did not manage to improve their skills throughout the three interviews. Our study presents a novel and repeatable pedagogical design, and our findings extend the body of knowledge aimed at RE education and training by providing an empirically grounded categorization of mistakes made by novices. We offer an analysis of the main pain points in which instructors should pay more attention during their design and training.

DOI: 10.1007/s00766-019-00313-0



Some examples of typical mistakes made by students in requirements elicitation interviews. Some of the mistakes can be corrected by providing explicit suggestions, such as “at the end of the interview, provide a summary to explain what you have understood” or “remember to ask probing questions, rephrasing what you heard from the customer”. Other behavioural mistakes, such as “no rapport with the customer” or “passive attitude” are harder to correct

Static analysis of featured transition systems

M.H. ter Beek, F. Damiani, M. Lienhardt, F. Mazzanti, L. Paolini

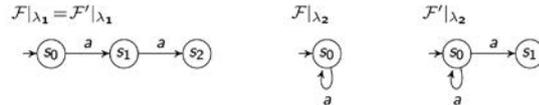
23rd International Systems and Software Product Line Conference (SPLC'19). ACM, 2019.

A featured transition system (FTS) is a formal behavioural model for software product lines (SPLs), which represents the behaviour of all the products of an SPL in a single compact structure by associating transitions with features that condition their existence in products. In general, an FTS may contain featured transitions that are unreachable in any product (so called dead transitions) or, on the contrary, mandatorily present in all products for which their source state is reachable (so called false optional transitions), as well as states from which only for certain products progress is possible (so called hidden deadlocks). In this paper, we provide algorithms to analyse an FTS for such ambiguities and to transform an ambiguous FTS into an unambiguous FTS. The scope of our approach is twofold. First and foremost, an ambiguous model is typically undesired as it gives an unclear idea of the SPL. Second, an unambiguous FTS paves the way for efficient family-based model check-

Ambiguous FTSs \mathcal{F} and \mathcal{F}'



LTSs of products $\lambda_1 = \{f_1\}$ and $\lambda_2 = \{f_2\}$ of the FTSs \mathcal{F} and \mathcal{F}'



Unambiguous FTSs \mathcal{F}_* and \mathcal{F}'_* obtained from the FTSs \mathcal{F} and \mathcal{F}'



ing. We apply our approach to illustrative benchmark examples from the literature.

DOI: 10.1145/3336294.3336295

This paper was decorated with an ACM reusable artifact badge, based on the publicly available Python code, and it won the best paper award at SPLC 2019.

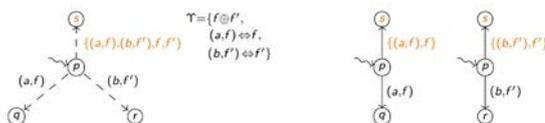
On the expressiveness of modal transition systems with variability constraints

M.H. ter Beek, F. Damiani, S. Gnesi, F. Mazzanti, L. Paolini

Science of Computer Programming, vol. 169. Elsevier, 2019.



Featured transition system \mathcal{F} (left) and its variants $\mathcal{F}|_{\lambda}$ and $\mathcal{F}|_{\lambda'}$ (right) as used in the literature to prove that \mathcal{F} cannot be encoded as a modal transition system



A transformation of \mathcal{F} into the modal transition system \mathcal{M} with variability constraints (left) and its variants (right) as used in the paper to prove that \mathcal{F} can be encoded as a modal transition system with variability constraints

proving the soundness and completeness of both transformations. Modal transition systems and featured transition systems are widely recognised as fundamental behavioural models for software product lines and our results thus contribute to the expressiveness hierarchy of such basic models studied in the literature.

DOI: 10.1016/j.scico.2018.09.006

In this paper, we demonstrate that modal transition systems with variability constraints are equally expressive as featured

transition systems, by defining a transformation of the latter into the former, a transformation of the former into the latter, and

Scalable approaches for test suite reduction

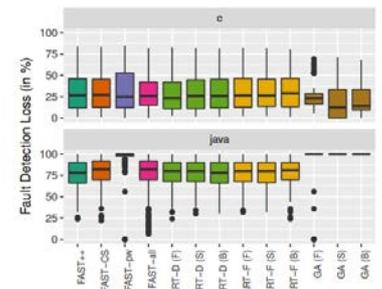
E. Cruciani, B. Miranda, R. Verdecchia, A. Bertolino

41st ACM/IEEE International Conference on Software Engineering (ICSE 2019). IEEE 2019.

Test suite reduction approaches aim at decreasing software regression testing costs by selecting a representative subset from large-size test suites. Most existing techniques are too expensive for handling modern massive systems and moreover depend on artifacts, such as code coverage metrics or specification models, that are not commonly available at large scale. The paper introduces a family of novel very efficient approaches for similarity-based test suite reduction that apply algorithms borrowed from the big data domain together with smart heuristics for finding an evenly spread subset of test cases. The approaches are

very general since they only use as input the test cases themselves (test source code or command line input). Four approaches have been evaluated in a version that selects a fixed budget B of test cases, and also in an adequate version that does the reduction guaranteeing some fixed coverage. The results show that the approaches yield a fault detection loss comparable to state-of-the-art techniques, while providing huge gains in terms of efficiency. When applied to a suite of more than 500K real world test cases, the most efficient of the four approaches could select B test cases (for varying B values) in less than 10 seconds.

DOI: 10.1109/ICSE.2019.00055



FDL for the test suite reduction approaches (in %)

On extending and comparing Newton–Raphson variants for solving power-flow equations

S. Dutto, G. Masetti, S. Chiaradonna, F. Di Giandomenico

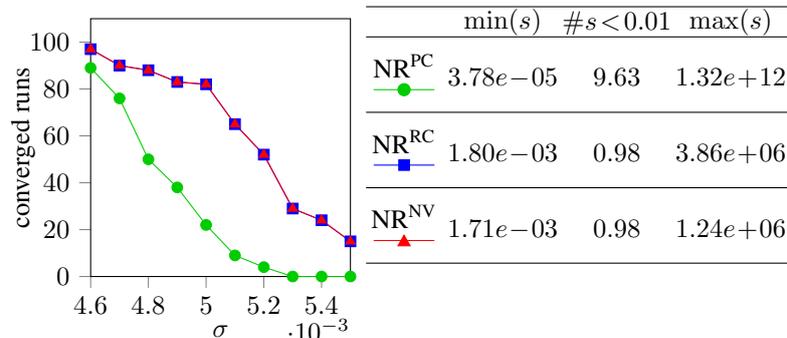
IEEE Transactions on Power Systems, vol. 34. IEEE 2019.

This paper focuses on power-flow equations solutions, based on the Newton–Raphson method. Two major contributions are offered. First, the definition of novel solution variants, resorting to Wirtinger calculus, is attempted. The obtained developments, though original in their formulation, led to already known variants. Despite the impaired originality of the obtained solution,

there are significant lessons learned from such an effort. The second contribution consists of a deep comparison analysis of existing solution strategies, based on complex and real variables, and the Wirtinger based ones, all properly reformulated to allow direct comparison with each other. The goal is to investigate strengths and weaknesses of the addressed techniques in terms

of computational effort and convergence rate, which are the most relevant aspects to consider while choosing the approach to employ to solve power-flow equations for a specific power system under study.

DOI: 10.1109/TPWRS.2019.2897640

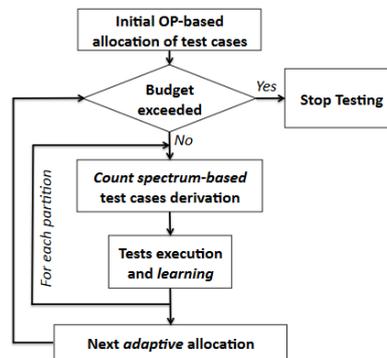


Convergence behavior for case6470rte [16] with random initial voltages: The effect of changing σ on the number of converged runs (on the left) and the mean of data concerning singular values of the Jacobian when the strategies do not converge (on the right)

Adaptive test case allocation, selection and generation using coverage spectrum and operational profile

A. Bertolino, B. Miranda, R. Pietrantuono, S. Russo
IEEE Transactions on Software Engineering. IEEE 2019.

We present an adaptive software testing strategy for test case allocation, selection and generation, based on the combined use of operational profile and coverage spectrum, aimed at achieving high delivered reliability of the program under test. Operational profile-based testing is a black-box technique considered well suited when reliability is a major concern, as it selects the test cases having the largest impact on failure probability in operation. Coverage spectrum is a characterization of a program's behavior in terms of the code entities (e.g., branches, statements, functions) that are covered as the program executes. The proposed strategy - named covrel+ - complements operational profile information with white-box coverage measures, so as to adaptively se-



The covrel+ strategy

lect/generate the most effective test cases for improving reliability as testing proceeds. We assess covrel+ through experiments with subjects commonly used in software

testing research, comparing results with traditional operational testing. The results show that exploiting operational and coverage data in an integrated adaptive way allows generally to outperform operational testing at achieving a given reliability target, or at detecting faults under the same testing budget, and that covrel+ has greater ability than operational testing in detecting hard-to-detect faults.

DOI: 10.1109/TSE.2019.2906187

Embracing software process improvement in automotive through PISA model

F. Falcini, G. Lami
International Conference on Product-Focused Software Process Improvement (PROFES 2019). Springer, 2019.

Vehicles innovation is principally driven by electronics components and software that play today a predominant role for the vehicle's functions. Because the quality of on-board automotive electronic systems is strongly dependent on the quality of their development practices, car-makers and suppliers proactively focused on improvement of technical and organizational processes. In this setting, several reference standards for the assessment and improvement of auto-

motive electronics processes and projects have been conceived and used in the last decade. Although the effects of the application of them in automotive industry have been generally positive, getting compliance in the short period may represent, in some contexts, a target hardly achievable, or even a chimera. In this context, a novel scheme addressing both project evaluation and process improvement and targeting a hand-on approach for the practitioners has been re-

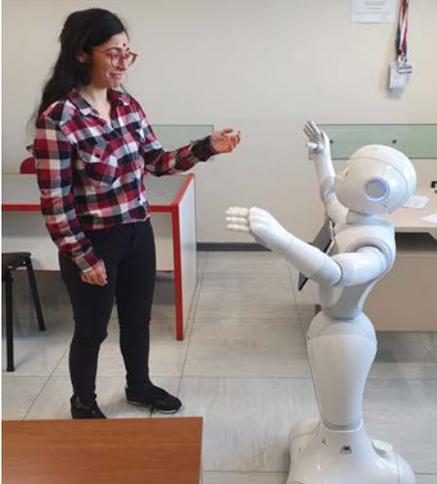
cently developed starting from the analysis of practitioners needs and success factors in the software process improvement. This scheme is named Process Improvement Scheme for Automotive (PISA Model). The structure and contents of the PISA Model is described in this paper.

DOI: 10.1007/978-3-030-35333-9_5

Trigger-action programming for personalising humanoid robot behaviour

N. Leonardi, M. Manca, F. Paternò, C. Santoro

ACM Conference on Human Factors in Computing Systems (CHI'19). ACM, 2019.



In the coming years humanoid robots will be increasingly used in a variety of contexts, thereby presenting many opportunities to exploit their capabilities in terms of what they can sense and do. One main challenge is to design technologies that enable those who are not programming experts to personalize robot behaviour. We propose an end user development solution based on trigger-action personalization rules. We describe how it supports editing such rules and its underlying software architecture, and report on a user test that involved end user developers. The test results show that

users were able to perform the robot personalization tasks with limited effort, and found the trigger-action environment usable and suitable for the proposed tasks. Overall, we show the potential for using trigger-action programming to make robot behaviour personalization possible even to people who are not professional software developers.

DOI: 10.1145/3290605.3300675z

Supporting end-user debugging of trigger-action rules for IoT applications

M. Manca, F. Paternò, C. Santoro, L. Corcella

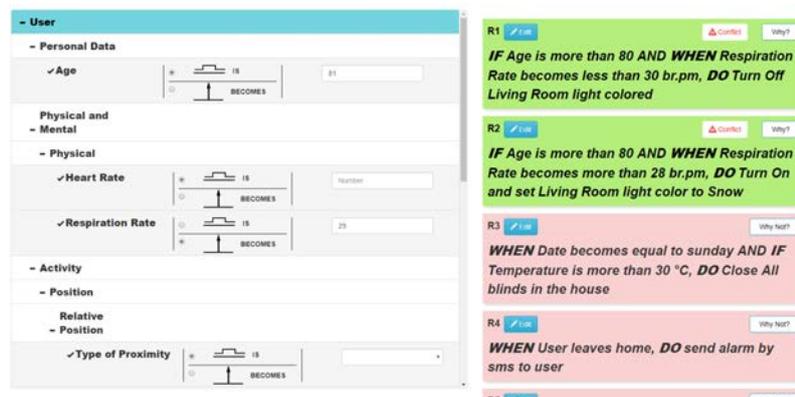
International Journal of Human-Computer Studies, vol. 123. Elsevier, 2019.

End users need tools to enable them to control and personalise Internet of Things (IoT) applications, which may involve hundreds of interconnected objects. Trigger-action programming has shown to be a useful support for this purpose because it allows users to easily associate dynamic events with the activation of desired effects. End User Development (EUD) tools aim to allow even users

without programming experience to define the behaviour of IoT applications. However, users may define rules triggering various actions that may be in conflict, or may specify rules that do not result in the intended behaviour. Although such situations can often occur, there seems to be a lack of tools able to help users understand whether the specified rules actually bring about the desired

behaviour and, if not, the reasons why they fail. We present an original solution for filling this gap, which takes into account the specific aspects of trigger-action rules. We describe the design and implementation of this debugging support, and then discuss the results of a first user test.

DOI: 10.1016/j.ijhcs.2018.11.005



The environment for executing rules in a simulated context of use

Personalized real-time anomaly detection and health feedback for older adults

P. Parvin, S. Chessa, M. Kaptein, F. Paternò

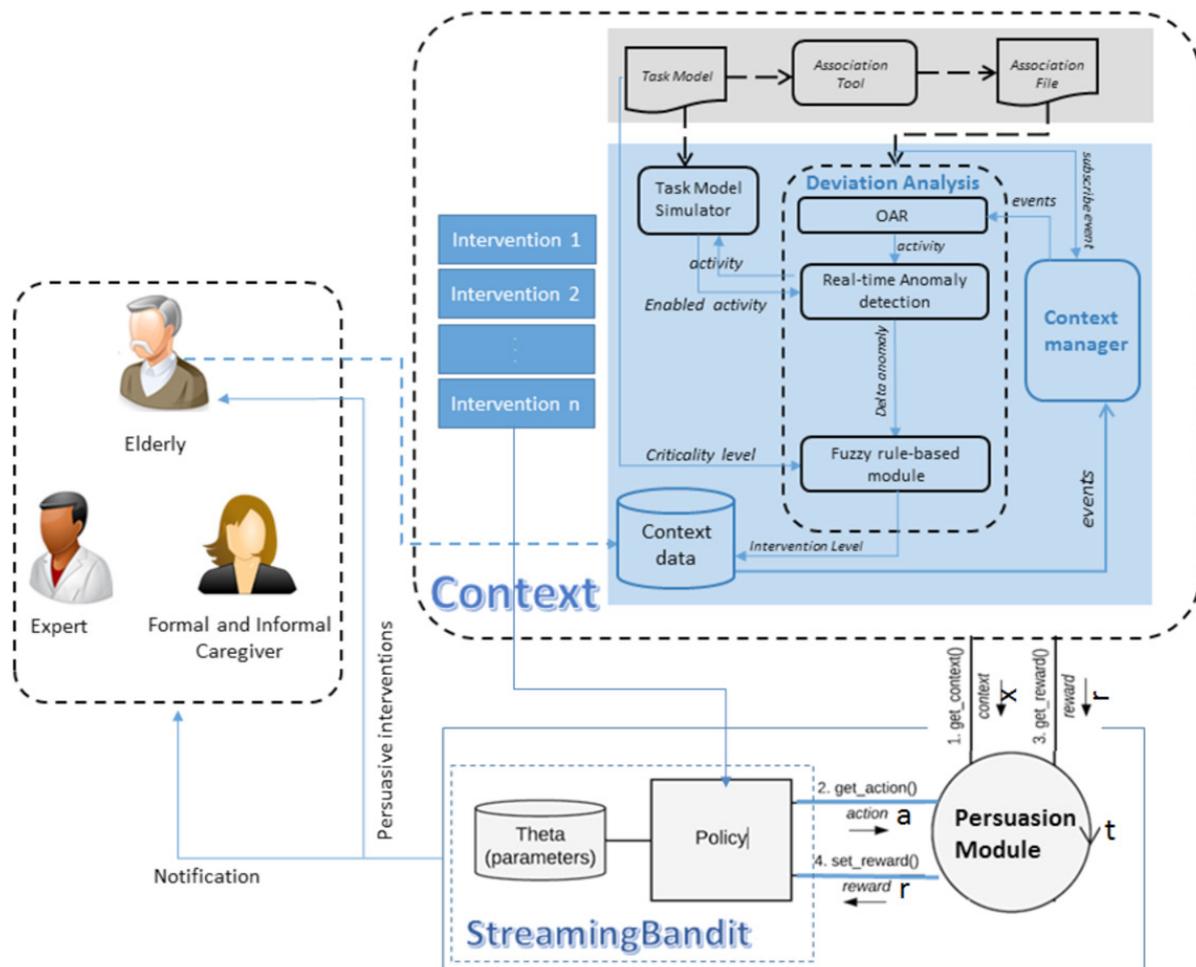
Journal of Ambient Intelligence and Smart Environments, vol. 11. IOS, 2019.

Rapid population aging and the availability of sensors and intelligent objects motivate the development of healthcare systems; these systems, in turn, meet the needs of older adults by supporting them to accomplish their day-to-day activities. Collecting information regarding older adults daily activity potentially helps to detect abnormal behavior. Anomaly detection can subsequently be combined with real-time, continuous and personalized interventions

to help older adults actively enjoy a healthy lifestyle. This paper introduces a system that uses a novel approach to generate personalized health feedback. The proposed system models user's daily behavior in order to detect anomalous behaviors and strategically generates interventions to encourage behaviors conducive to a healthier lifestyle. The system uses a Mamdani-type fuzzy rule-based component to predict the level of intervention needed for each detected

anomaly and a sequential decision-making algorithm, Contextual Multi-armed Bandit, to generate suggestions to minimize anomalous behavior. We describe the system's architecture in detail and we provide example implementations for the anomaly detection and corresponding health feedback.

DOI: 10.3233/AIS-190536



The architecture of the system

Algorithmic bias amplifies opinion fragmentation and polarization: a bounded confidence model

A. Sîrbu, D. Pedreschi, F. Giannotti, J. Kertész
Plos One, vol. 14. Public Library of Science, 2019.

The flow of information reaching us via the online media platforms is optimized not by the information content or relevance but by popularity and proximity to the target. This is typically performed in order to maximise platform usage. As a side effect, this introduces an algorithmic bias that is believed to enhance fragmentation and polarization of the societal debate. To study this phenomenon, we modify the well-known continuous opinion dynamics model of bounded confidence in order to account for the algorithmic bias and investigate its

consequences. In the simplest version of the original model the pairs of discussion participants are chosen at random and their opinions get closer to each other if they are within a fixed tolerance level. We modify the selection rule of the discussion partners: there is an enhanced probability to choose individuals whose opinions are already close to each other, thus mimicking the behavior of online media which suggest interaction with similar peers. As a result we observe: a) an increased tendency towards opinion fragmentation, which emerges also in con-

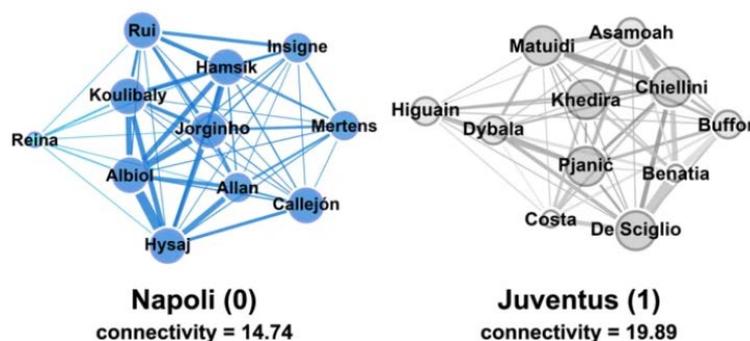
ditions where the original model would predict consensus, b) increased polarisation of opinions and c) a dramatic slowing down of the speed at which the convergence at the asymptotic state is reached, which makes the system highly unstable. Fragmentation and polarization are augmented by a fragmented initial population.

DOI: 10.1371/journal.pone.0213246

A public data set of spatio-temporal match events in soccer competitions

L. Pappalardo, P. Cintia, A. Rossi, E. Massucco, P. Ferragina, D. Pedreschi, F. Giannotti
Scientific Data, vol. 6. Springer, 2019.

Soccer analytics is attracting increasing interest in academia and industry, thanks to the availability of sensing technologies that provide high-fidelity data streams for every match. Unfortunately, these detailed data are owned by specialized companies and hence are rarely publicly available for scientific research. To fill this gap, this paper describes the largest open collection of soccer-logs ever released, containing all the spatio-temporal events (passes, shots, fouls, etc.) that occurred during each match for an entire season of seven promi-



Representation of the player passing networks of the match Napoli-Juventus. Nodes represent players, edges represent passes between players. The size of the nodes reflects the number of ingoing and outgoing passes (i.e. node's degree), while the size of the edges is proportional to the number of passes between the players.

nent soccer competitions. Each match event contains information about its posi-

tion, time, outcome, player and characteristics. The nature of team sports like soccer, half-way between the abstraction of a game and the reality of complex social systems, combined with the unique size and composition of this dataset, provide an ideal ground for tackling a wide range of data science problems, including the measurement and evaluation of performance, both at individual and at collective level, and the determinants of success and failure.

DOI: 10.1038/s41597-019-0247-7

PlayeRank: data-driven performance evaluation and player ranking in soccer via a machine learning approach

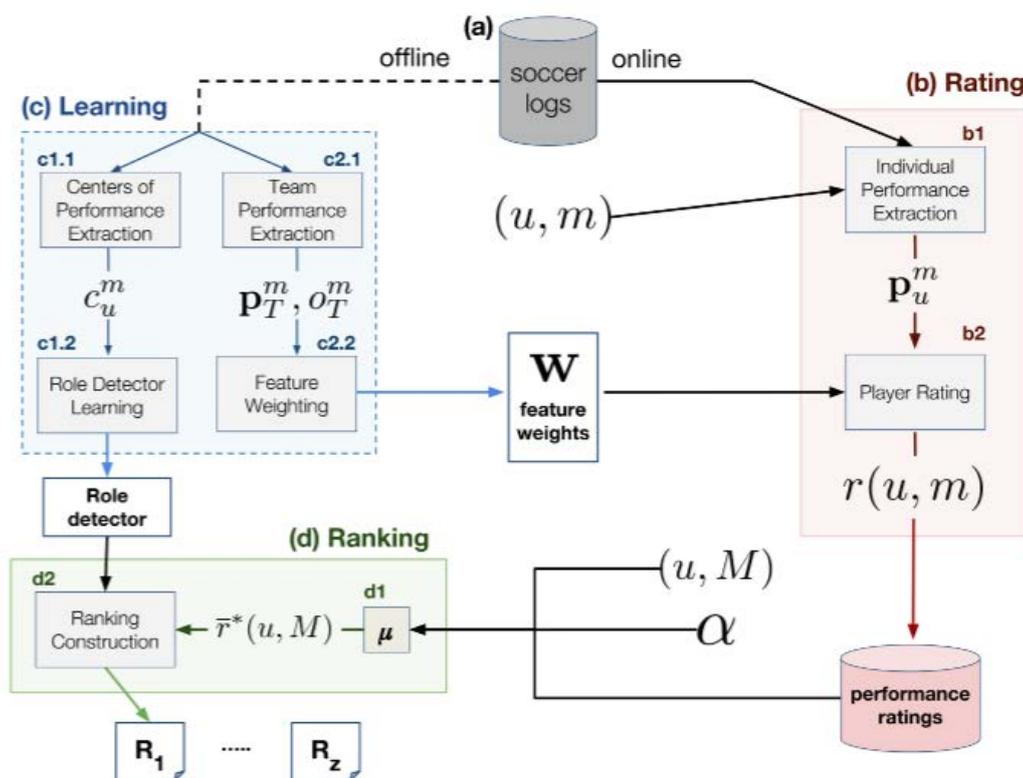
L. Pappalardo, P. Cintia, P. Ferragina, E. Massucco, D. Pedreschi, F. Giannotti
 ACM Transactions on Intelligent Systems and Technology, vol. 10. ACM, 2019

The problem of evaluating the performance of soccer players is attracting the interest of many companies and the scientific community, thanks to the availability of massive data capturing all the events generated during a match (e.g., tackles, passes, shots, etc.). Unfortunately, there is no consolidated and widely accepted metric for measuring performance quality in all of its facets. In this article, we design and implement PlayeRank, a data-driven framework that offers a principled multi-dimensional and role-aware evaluation of the performance of soccer

players. We build our framework by deploying a massive dataset of soccer-logs and consisting of millions of match events pertaining to four seasons of 18 prominent soccer competitions. By comparing PlayeRank to known algorithms for performance evaluation in soccer, and by exploiting a dataset of players' evaluations made by professional soccer scouts, we show that PlayeRank significantly outperforms the competitors. We also explore the ratings produced by PlayeRank and discover interesting patterns about the nature of excellent performances and

what distinguishes the top players from the others. At the end, we explore some applications of PlayeRank—i.e. searching players and player versatility—showing its flexibility and efficiency, which makes it worth to be used in the design of a scalable platform for soccer analytics.

DOI: 10.1145/3343172



Schema of the PlayeRank framework. Starting from a database of soccer-logs (a), it consists of three main phases. The learning phase (c) is an “offline” procedure: It must be executed at least once before the other phases, since it generates information used in the other two phases, but then it can be updated separately. The rating (b) and the ranking phases (d) are online procedures, i.e., they are executed every time a new match is available in the database of soccer-logs. We refer to the text for the notation used in the figure

Enacting open science by D4Science

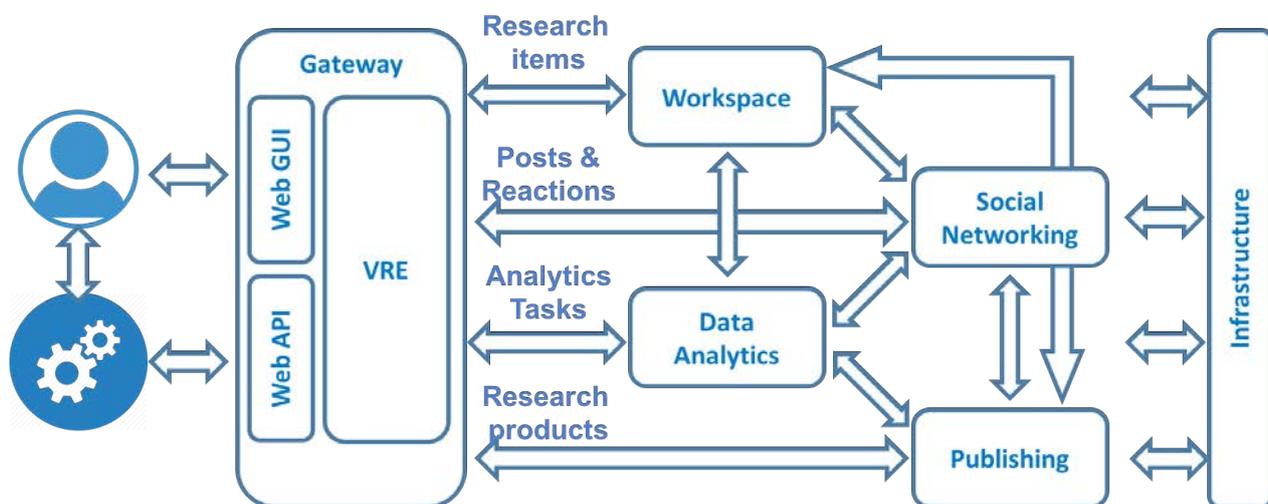
M. Assante, L. Candela, D. Castelli, R. Cirillo, G. Coro, L. Frosini, L. Lelii, F. Mangiacrapa, P. Pagano, G. Panichi, F. Sinibaldi
Future Generation Computer Systems, vol. 101. Elsevier, 2019.

The open science movement is promising to revolutionise the way science is conducted with the goal to make it more fair, solid and democratic. This revolution is destined to remain just a wish if it is not supported by changes in culture and practices as well as in enabling technologies. This paper de-

scribes the D4Science offerings to enact open science-friendly Virtual Research Environments. In particular, the paper describes how complete solutions suitable for realising open science practices can be achieved by integrating a social networking collaborative environment with a shared workspace,

an open data analytics platform, and a catalogue enabling to effectively find, access and reuse every research artefact.

DOI: 10.1016/j.future.2019.05.063



D4Science Open Science Services Framework

Introducing narratives in Europeana: a case study

C. Meghini, V. Bartalesi, D. Metilli, F. Benedetti

International Journal of Applied Mathematics and Computer Science, vol29. University of Zielona Góra, 2019.

We present a preliminary study to introduce narratives as a first-class functionality in digital libraries. The general idea is to enrich those libraries with semantic networks of events providing a meaningful contextualisation of the digital libraries' objects. More specific motivations are presented through a set of use cases by different actors who would benefit from using narratives for different purposes. Then, we con-

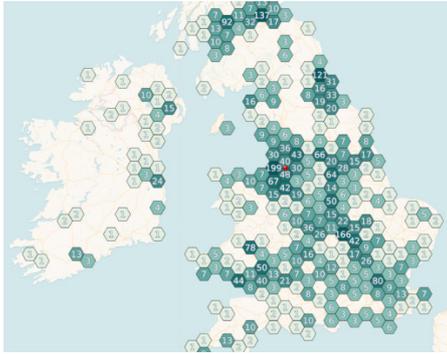
sider a specific digital library, Europeana, the largest European digital library in the cultural heritage domain. We discuss how the Europeana Data Model could be extended for representing narratives, and we introduce an ontology for narratives. We also present a semi-automatic tool, which, on the basis of the ontology, supports the creation and visualisation of narratives, and we show how the tool has been em-

ployed to create a narrative of the life of the painter Gustav Klimt as a case study. In particular, we focus our attention on the functionality of the tool that allows extracting and proposing to the user specific digital objects for each event of the narrative.

DOI: 10.2478/amcs-2019-0001

Event attendance classification in social media

V. Monteiro de Lira, C. Macdonald, I. Ounis, R. Perego, C. Renso, V. Cesario
 Information Processing & Management, vol. 56. Elsevier, 2019.



Spatial distribution of inferred participants to the Creamfields festival (red point) from posts published before the event

Popular events are well reflected on social media, where people share their feelings and discuss their experiences. In this paper, we investigate the novel problem of exploiting the content of non-geotagged posts on social media to infer the users' attendance of large events in three temporal periods: before, during and after an event. We detail the features used to train event attendance classifiers and report on experiments conducted on data from two large music festivals in the UK, namely the VFestival and Creamfields events. Our classifiers

attain very high accuracy with the highest result observed for the Creamfields festival (91% accuracy at classifying users that will participate in the event). We study the most informative features for the tasks addressed and the generalization of the learned models across different events. Finally, we discuss an illustrative application of the methodology in the field of transportation.

DOI: 10.1016/j.ipm.2018.11.001

Parallel traversal of large ensembles of decision trees

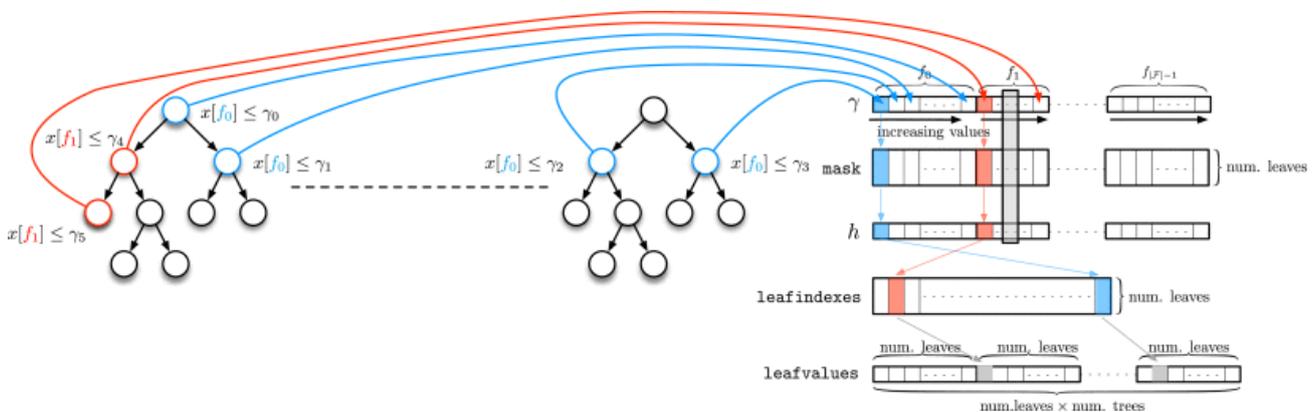
F. Lettich, C. Lucchese, F.M. Nardini, S. Orlando, R. Perego, N. Tonello, R. Venturini
 IEEE Transactions on Parallel and Distributed Systems, , vol. 30. IEEE, 2019.

Machine-learned models based on additive ensembles of regression trees are currently deemed the best solution to address complex classification, regression, and ranking tasks. The deployment of such models is computationally demanding: to compute the final prediction, the whole ensemble must be traversed by accumulating the contributions of all its trees. In particular, traversal cost impacts applications where the

number of candidate items is large, the time budget available to apply the learnt model to them is limited, and the users' expectations in terms of quality-of-service is high. Document ranking in web search, where sub-optimal ranking models are deployed to find a proper trade-off between efficiency and effectiveness of query answering, is probably the most typical example of this challenging issue. This paper investigates

multi/many-core parallelization strategies for speeding up the traversal of large ensembles of regression trees thus obtaining machine-learned models that are, at the same time, effective, fast, and scalable. Our best results are obtained by the GPU-based parallelization of the state-of-the-art algorithm, with speedups of up to 102.6x.

DOI: 10.1109/TPDS.2018.2860982



Data layout example of the QS algorithm

Generalized bayesian model selection for speckle on remote sensing images

O. Karakuş, E.E. Kuruoğlu, M.A. Altınkaya

IEEE Transactions on Image Processing, vol. 28. IEEE, 2019.

Synthetic aperture radar (SAR) and ultrasound (US) are two important active imaging techniques for remote sensing, both of which are subject to speckle noise caused by coherent summation of back-scattered waves and subsequent nonlinear envelope transformations. Estimating the characteristics of this multiplicative noise is crucial to develop denoising methods and to improve statistical inference from remote sensing images. In this paper, reversible jump Mar-

kov chain Monte Carlo (RJMCMC) algorithm has been used with a wider interpretation and a recently proposed RJMCMC-based Bayesian approach, trans-space RJMCMC, has been utilized. The proposed method provides an automatic model class selection mechanism for remote sensing images of SAR and US where the model class space consists of popular envelope distribution families. The proposed method estimates the correct distribution family, as well as the

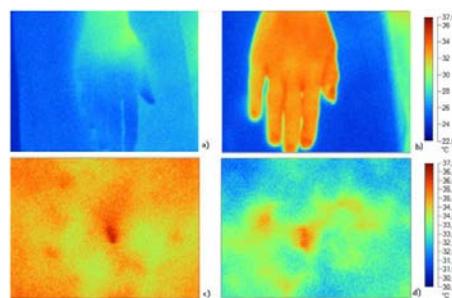
shape and the scale parameters, avoiding performing an exhaustive search. For the experimental analysis, different SAR images of urban, forest and agricultural scenes, and two different US images of a human heart have been used. Simulation results show the efficiency of the proposed method in finding statistical models for speckle.

DOI: 10.1109/TIP.2018.2878322

A pilot study of infrared thermography based assessment of local skin temperature response in overweight and lean women during oral glucose tolerance test

B. Jalil, V. Hartwig, D. Moroni, O. Salvetti, A. Benassi, Z. Jalil, L. Pistoia, T. Minutoli Tegrimi, A. Quinones-Galvan, G. Iervasi, A. L'Abbate, L. Guiducci
Journal of Clinical Medicine, vol. 8. MDPI, 2019.

Obesity is recognized as a major public health issue, as it is linked to the increased risk of severe pathological conditions. The aim of this pilot study is to evaluate the relations between adiposity (and biophysical characteristics) and temperature profiles under thermoneutral conditions in normal and overweight females, investigating the potential role of heat production/dissipation alteration in obesity. We used Infrared Thermography (IRT) to evaluate the thermogenic response to a metabolic stimulus performed with an oral glucose tolerance test (OGTT). Thermographic images of the right hand and of the central abdomen (regions of interests) were obtained basally and during the oral glucose tolerance test (3 h OGTT with the ingestion of 75 g of oral glucose) in normal and



Example of an IRT image of hand and abdomen of a lean (a,c) and an overweight (b,d) subject at rest. Hand temperature is higher in the overweight subject compared to the lean subject, while abdominal temperature is higher in the lean subject

overweight females. Regional temperature vs BMI, % of body fat and abdominal skinfold were statistically compared between two groups. The study showed that mean abdominal temperature was significantly greater in lean than overweight participants

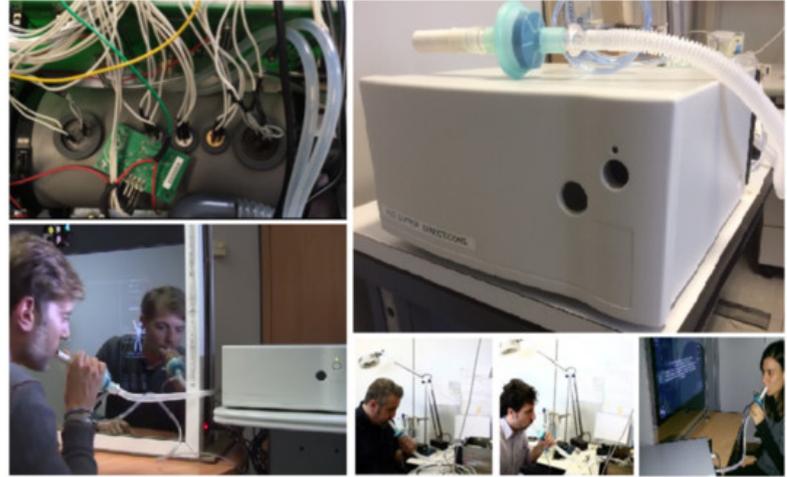
(34.11 ± 0.70 °C compared with 32.92 ± 1.24 °C, $p < 0.05$). Mean hand temperature was significantly greater in overweight than lean subjects (31.87 ± 3.06 °C compared with 28.22 ± 3.11 °C, $p < 0.05$). We observed differences in temperature profiles during OGTT between lean and overweight subjects: The overweight individuals depict a flat response as compared to the physiological rise observed in lean individuals. This observed difference in thermal pattern suggests an energy rate imbalance towards nutrients storage of the overweight subjects.

DOI: 10.3390/jcm8020260

An e-nose for the monitoring of severe liver impairment: a preliminary study

D. Germanese, S. Colantonio, M. D'Acunto, V. Romagnoli, A. Salvati, M. Brunetto
 Sensors, vol. 19. MDPI, 2019.

Biologically inspired to mammalian olfactory system, electronic noses became popular during the last three decades. In literature, as well as in daily practice, a wide range of applications are reported. Nevertheless, the most pioneering one has been (and still is) the assessment of the human breath composition. In this study, we used a prototype of electronic nose, called Wize Sniffer (WS) and based it on an array of semiconductor gas sensor, to detect ammonia in the breath of patients suffering from severe liver impairment. In the setting of severely impaired liver, toxic substances, such as ammonia, accumulate in the systemic circulation and in the brain. This may result in Hepatic Encephalopathy (HE), a spectrum of neuro-psychiatric abnormalities which include changes in cognitive functions, consciousness, and behaviour. HE can be detected only by specific but time-consuming and burdensome examinations, such as blood ammonia



The Wize Sniffer (WS). On the top, left: the gas sensors in the gas sampling chamber are shown. On the top, right: WS external configuration. Others: the WS while performing a breath test

levels assessment and neuro-psychological tests. In the presented proof-of-concept study, we aimed at investigating the possibility of discriminating the severity degree of liver impairment on the basis of the detected

breath ammonia, in view of the detection of HE at its early stage.

DOI: 10.3390/s19173656

Fault detection in power equipment via an unmanned aerial system using multi modal data

B. Jalil, G.R. Leone, M. Martinelli, D. Moroni, M.A. Pascali, A. Berton
 Sensors vol. 19. MDPI, 2019.

The power transmission lines are the link between power plants and the points of consumption, through substations. Most importantly, the assessment of damaged aerial power lines and rusted conductors is of extreme importance for public safety; hence, power lines and associated components must be periodically inspected to ensure a continuous supply and to identify any fault and defect. To achieve these objectives, recently, Unmanned Aerial Vehicles (UAVs) have been widely used; in fact, they

provide a safe way to bring sensors close to the power transmission lines and their associated components without halting the equipment during the inspection, and reducing operational cost and risk. In this work, a drone, equipped with multi-modal sensors, captures images in the visible and infrared domain and transmits them to the ground station. We used state-of-the-art computer vision methods to highlight expected faults (i.e., hot spots) or damaged components of the electrical infrastructure

(i.e., damaged insulators). Infrared imaging, which is invariant to large scale and illumination changes in the real operating environment, supported the identification of faults in power transmission lines; while a neural network is adapted and trained to detect and classify insulators from an optical video stream. We demonstrate our approach on data captured by a drone in Parma, Italy.

DOI: 10.3390/s19133014

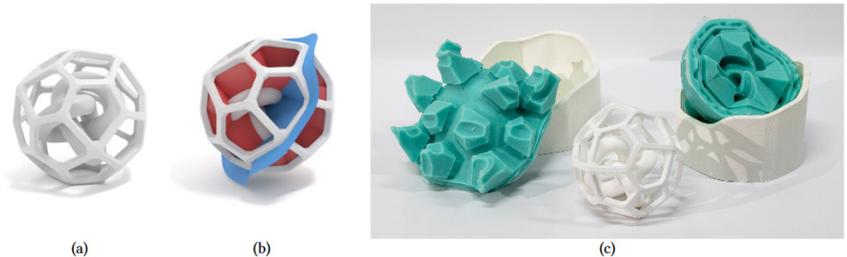
Volume-aware design of composite molds

T. Alderighi, L. Malomo, D. Giorgi, B. Bickel, P. Cignoni, N. Pietroni
ACM Transactions on Graphics, vol. 38. ACM, 2019.

We propose a novel technique for the automatic design of molds to cast highly complex shapes. The technique generates composite, two-piece molds. Each mold piece is made up of a hard plastic shell and a flexible silicone part. Thanks to the thin, soft, and smartly shaped silicone part, which is kept in place by a hard plastic shell, we can cast objects of unprecedented complexity. An innovative algorithm based on a volumetric analysis defines the layout of the internal cuts in the silicone mold part. Our approach can robustly handle thin protruding features and intertwined topologies that have caused previous methods to fail. We compare our

results with state of the art techniques, and we demonstrate the casting of shapes with extremely complex geometry.

DOI: 10.1145/3306346.3322981



Our technique for casting extremely complex shapes up to (a) objects made up of multiple entangled pieces. (b) We design a cut layout in the mold volume, which is defined by a parting surface membrane (blue) and a set of additional membranes to enforce moldability (red). (c) We assemble a composite mold made up of a hard plastic shell and a soft silicone part, and then fabricate the given object using liquid casting techniques

QuadMixer: layout preserving blending of quadrilateral meshes

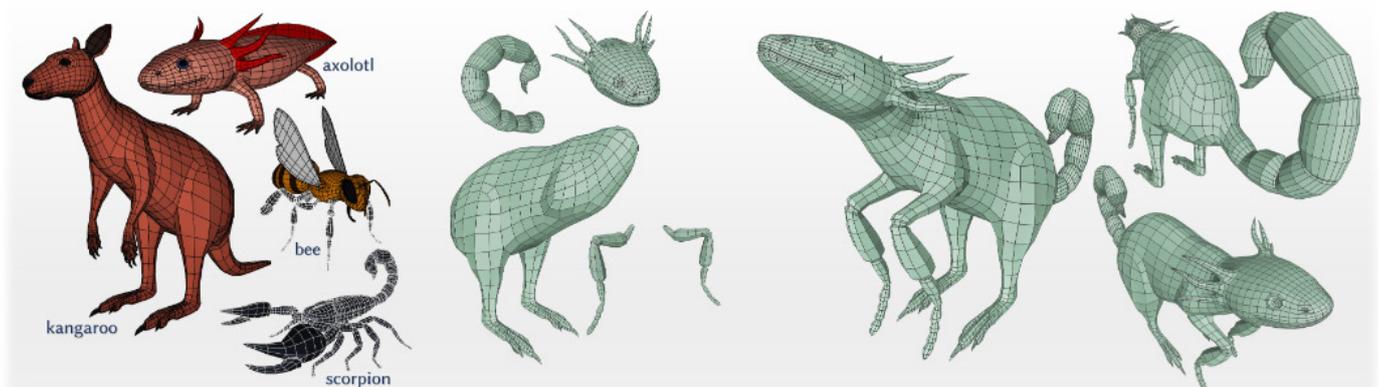
S. Nuvoli, A. Hernandez, C. Esperança, R. Scateni, P. Cignoni, N. Pietroni
ACM Transactions on Graphics, vol. 38. ACM, 2019.

We propose QuadMixer, a novel interactive technique to compose quad mesh components preserving the majority of the original layouts. Quad Layout is a crucial property for many applications since it conveys important information that would otherwise be destroyed by techniques that aim only at preserving shape. Our technique keeps untouched all the quads in

the patches which are not involved in the blending. We first perform robust boolean operations on the corresponding triangle meshes. Then we use this result to identify and build new surface patches for small regions neighboring the intersection curves. These blending patches are carefully quadrangulated respecting boundary constraints and stitched back to the untouched parts

of the original models. The resulting mesh preserves the designed edge flow that, by construction, is captured and incorporated to the new quads as much as possible. We present our technique in an interactive tool to show its usability and robustness.

DOI: 10.1145/3355089.3356542

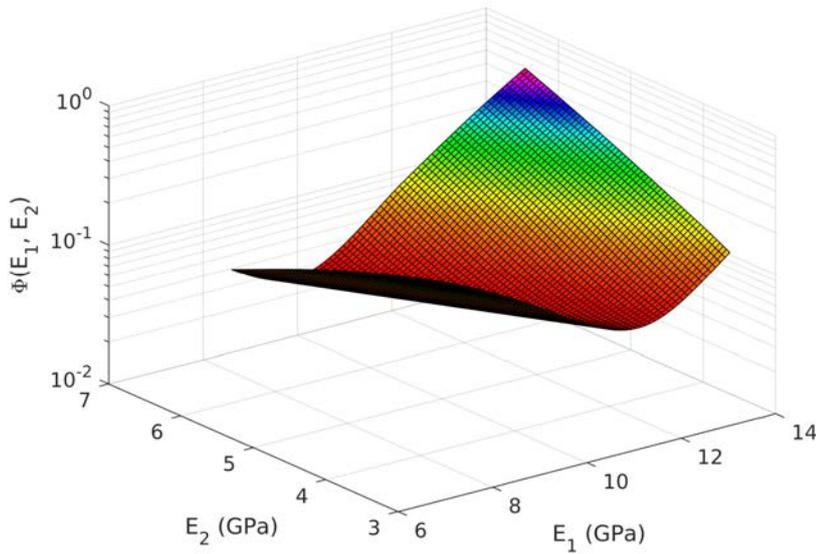


With the proposed blending technique we can assemble pieces of different animals respecting the original quad meshing. In less than ten minutes we detached and combined these body pieces to automatically obtain the pure quad mesh shown on the right

Model updating procedure to enhance structural analysis in FE Code NOSA-ITACA

M. Girardi, C. Padovani, D. Pellegrini, L. Robol

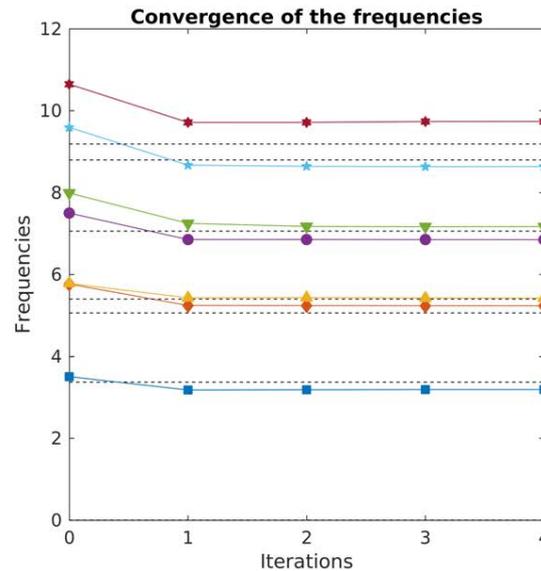
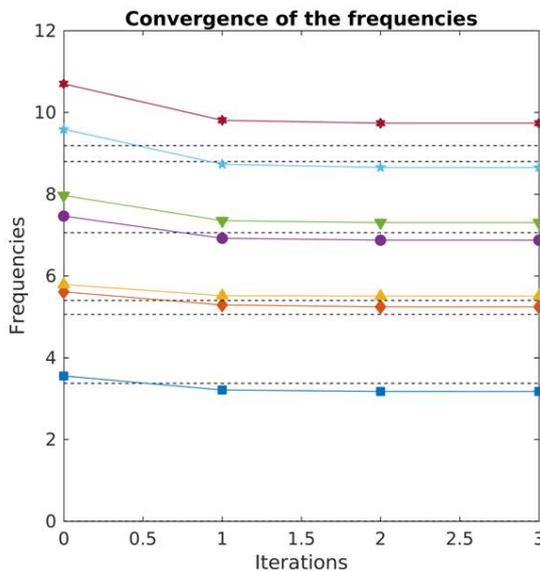
Journal of Performance of Constructed Facilities, vol. 33. ASCE, 2019.



The Maddalena Bridge, mesh 2: objective function $122(\cdot, \cdot)EEp\Phi$ vs. E_1 and E_2

This paper describes a model updating procedure implemented in NOSA-ITACA, a finite-element (FE) code for the structural analysis of masonry constructions of historical interest. The procedure, aimed at matching experimental frequencies and mode shapes, allows for fine-tuning the calculations of the free parameters in the model. The numerical method is briefly described, and some issues related to its robustness are addressed. The procedure is then applied to a simple case study and two historical structures in Tuscany, the Clock Tower in Lucca and the Maddalena Bridge in Borgo a Mozzano.

DOI: 10.1061/(ASCE)CF.1943-5509.0001303



The Maddalena Bridge: convergence history for mesh 1 (on the left) and mesh 2

Uncontrolled re-entries of spacecraft and rocket bodies: a statistical overview over the last decade

C. Pardini, L. Anselmo

The Journal of Space Safety Engineering, vol. 6. Elsevier, 2019.

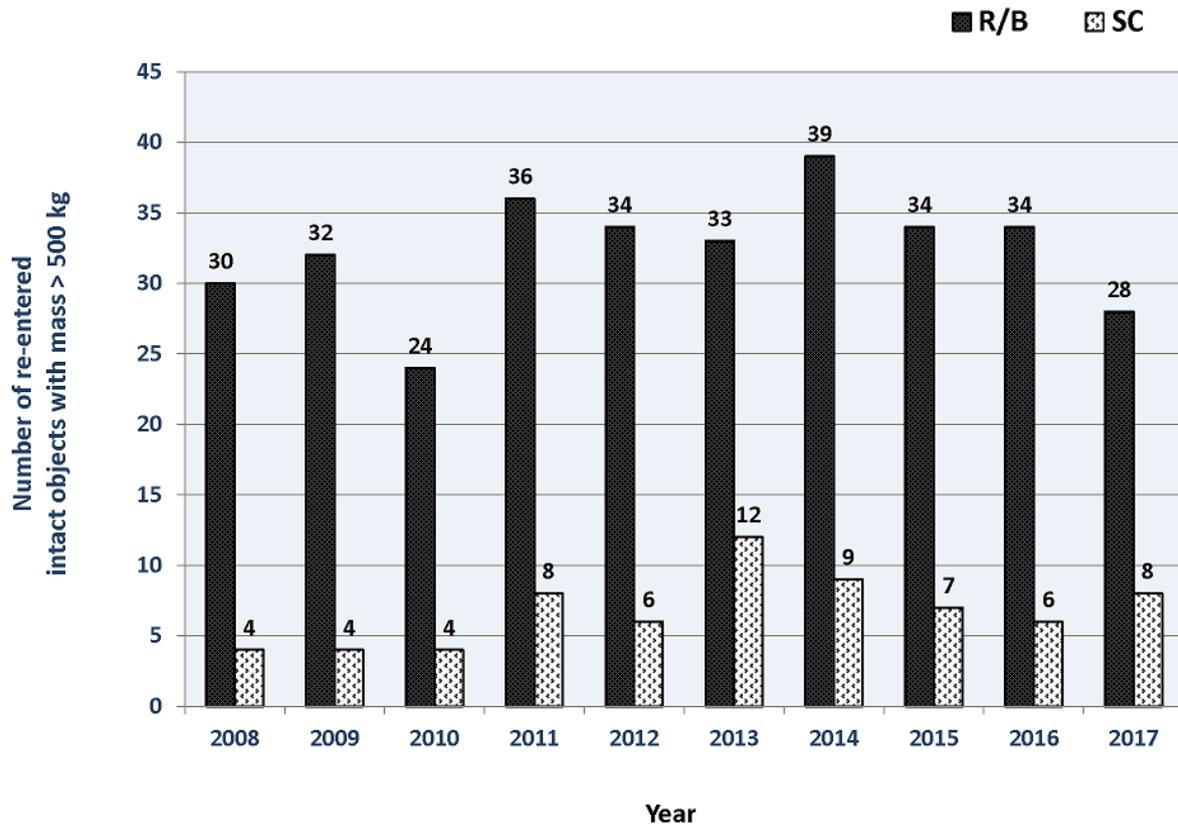
More than 24,400 catalogued orbiting objects have re-entered so far into the Earth's atmosphere since the beginning of the space age. The associated returning mass, close to 30,000 metric tons, was mainly concentrated in intact objects, i.e. payloads and spent upper stages, accounting for nearly 29% of the re-entered objects. During the 10 years from 2008 to 2017, almost 450 large intact objects have re-entered without control, with a total returning mass of approximately 900 metric tons. Since the beginning of 2018 until mid-November, nearly 86 metric tons of returned materials were associated with almost 65 uncontrolled re-entries of

large intact objects, three of which with a mass exceeding 5 metric tons: the Zenit-3F second stage 2017-086D, the C-25 cryogenic upper stage 2017-031B, and the Chinese space station Tiangong-1.

After an overview of the most critical historic re-entry events, the attention will be focused on the re-entries of massive objects occurred without control from 2008 to 2017, by categorizing them in terms of relevance, reentry frequency, returned mass, distribution in inclination, overflown latitude bands, eccentricity and perigee/apogee altitudes before re-entry. Cases in

which spacecraft and rocket bodies components were retrieved, and eyewitnesses' sightings were reported, will be presented as well. Finally, the relevant re-entries occurred without control in 2018 will be discussed, while conclusions will be drawn concerning the potential growing risk on the ground and in mid-air due to fragments surviving the re-entry.

DOI: 10.1016/j.jssse.2019.02.0010



NILSME

Experimentation of the new Sentinel missions for the observation of inland water bodies on the course of the Nile River

NILSME is a bilateral project carried out by ISTI and Zagazig University (Egypt), and jointly funded by CNR and ASRT (the Egyptian Academy of Scientific Research and Technology). This project aims at studying the potentiality of the new constellation of satellites launched by ESA (the "Sentinel" missions) for the observation of inland water bodies along the course of the Nile River. Our attention is currently focused on the Nasser Lake, the biggest and most important lake in Egypt, located in the southern part of the Nile River in Upper Egypt. The investigation regards quantitative assessments of the storage capacity of water reservoirs and morphological alterations in waterways.

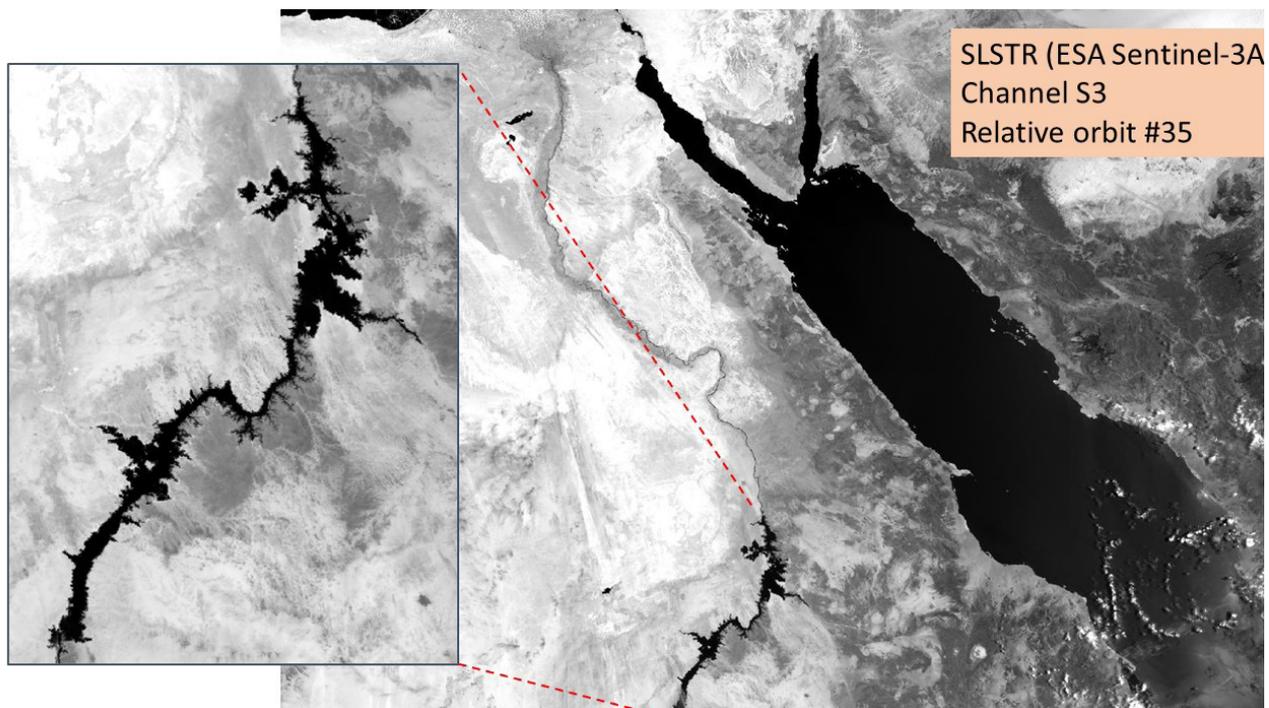
The Nile River has a relatively modest discharge if compared to other major rivers in the world. In this critical context, considerable threats are represented by a growing population and developmental pressure with climate change providing additional impact. This means that there is a crucial need for adequate infrastructures and monitoring of this resource.

In-situ measurements can be conveniently complemented by remote sensing observations, both for cross-validation purposes and for the assessment of poorly gauged or inaccessible sites. The free and open availability of the new Sentinel missions, in the frame of the Copernicus services, opens

an unprecedented opportunity to make hydrological assessments on a regular basis, thanks to the global coverage and the relatively short revisit times of these operational missions developed by the European Space Agency.

The picture shows an image generated by the SLSTR sensor (Sea and Land Surface Temperature Radiometer) onboard Sentinel-3 in a Near-Infrared band, which is used for water mapping. The inset contains the whole Lake Nasser.

Contact: Andrea Scozzari, SI Lab
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Young researcher award “Matteo Dellepiane” 2019

The ISTI Young Researcher Award (YRA) “Matteo Dellepiane” is an annual award that honors its staff of less than 35 years old for a distinct contribute to the Institute activity with their scientific production. There are two categories:

- Young Researcher - Beginner - awarded to researchers less than 32 years old;
- Young Researcher - Advanced - awarded to Ph.D. students and Ph.D. researchers less than 35 years old.

Contact: Franco Maria Nardini, HPC Lab
franco.nardini@isti.cnr.it

Beginner



**Antonino
Crivello**



**Riccardo
Guidotti**



**Leonardo
Robol**

Advanced



**Luigi
Malomo**



**Luca
Pappalardo**



**Giulio
Rossetti**

Best paper award ISCC 2019

24th edition of ISCC – IEEE Symposium on Computers and Communications, Workshop on ICT Solutions for eHealth (ICTS4eHealth) - Barcelona (Spain), June 30, 2019

The paper Towards Chronic Liver Dysfunction Self-monitoring: a Proof-of-Concept study by Danila Germanese, Sara Colantonio, Mario D’Acunto, Maurizia Brunetto, Veronica Romagnoli and Antonio Salvati, presented by Danila Germanese at the 24th edition of ISCC - Workshop on ICT Solutions for eHealth (ICTS4eHealth), has been awarded as Best Paper.

The paper focuses on a proof-of-concept study that aimed at detecting ammonia in the breath of patients suffering from chronic liver disease by means of a low-cost, easy-to-use, gas sensors based device. Also, the possibility of discriminating the several severity degree of liver impairment on the basis of the detected ammonia was investigated.

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danila.germanese@isti.cnr.it
<http://si.isti.cnr.it/index.php/news/159-news-best-paper-iscc>

The ARCHAIDE project won a prize at the heritage in motion competition

The ARCHAIDE project is funded by the European Union's Horizon 2020 research and innovation programme, and has CNR-ISTI as one of the main partners and initial promoter, with the department of Civiltà e Forme del Sapere of the University of Pisa (project

leader). The project, focused on Cultural Heritage, has as its core idea the use of deep learning and artificial intelligence Heritage in Motion is a multimedia competition for the creators and users of films, games, apps and websites on themes related to Europe's

heritage, cultural and natural, tangible and intangible. The competition is organized by Europeana.

<http://www.archaide.eu/>

Best paper award SPLC 2019, September 9-13

Best Paper Award for the paper "Static Analysis of Featured Transition Systems" by Maurice H. ter Beek, Ferruccio Damiani, Michael Lienhardt, Franco Mazzanti, and Luca Paolini presented at the 23rd Systems and Software Product Line Conference (SPLC 2019) in Paris, France.



From left to right: Thomas Thüm, Maurice ter Beek, Ferruccio Damiani, Michael Lienhardt, Laurence Duchien

Contact: Maurice ter Beek and Franco Mazzanti, FMT Lab
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<https://splc2019.net/>

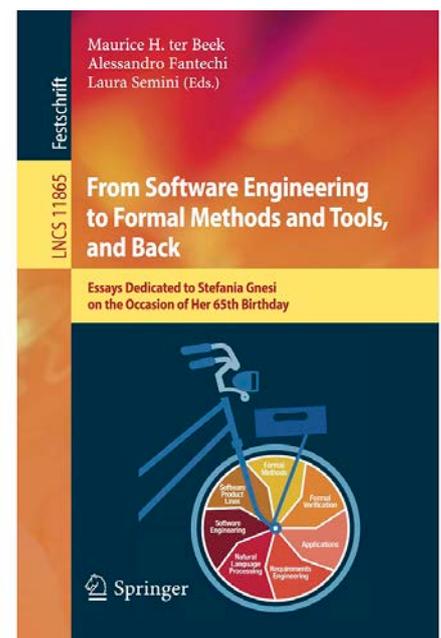
Festschrift and Colloquium in Honour of Stefania Gnesi

Third World Congress on Formal Methods, Porto, Portugal, October 8, 2019

Many colleagues and friends of Stefania Gnesi gathered during the 3rd World Congress on Formal Methods in Porto for a one-day colloquium in her honour. The presentations accompanied a Festschrift (published by Springer as volume 11865 of the Lecture Notes in Computer Science series) with 32 contributions by collaborators and colleagues of Stefania Gnesi to celebrate her 65th birthday. The Festschrift consists of eight sections, seven of which reflect the main research areas to which Stefania has contributed. Following a survey of Stefania's legacy in research and a homage by

her thesis supervisor, these seven sections are ordered according to Stefania's life cycle in research, from software engineering to formal methods and tools, and back:

- Software Engineering
- Formal Methods and Tools
- Requirements Engineering
- Natural Language Processing
- Software Product Lines
- Formal Verification
- Applications



<https://www.springer.com/gp/book/9783030309848>

Best paper award CBMI 2019, 4-6 Sept.

A research work, made by members of the Artificial Intelligence for Multimedia Information Retrieval (AIMIR) research group, received the Best Paper award at the International Conference on Content-Based Multimedia Indexing 2019, Dublin, Ireland. The awarded paper is “Learning Safety Equipment Detection using Virtual Worlds” by Marco di Benedetto, Enrico Meloni, Giuseppe Amato, Fabrizio Falchi, and Claudio Gennaro

Abstract: Nowadays, the possibilities offered by state-of-the-art deep neural networks allow the creation of systems capable of recognizing and indexing visual content with very high accuracy. Performance of these systems relies on the availability of high-quality training sets, containing a large number of examples (e.g., million), in addition to the machine learning tools themselves. For several applications, very good training sets can be obtained, for example, crawling (noisily) annotated images from the internet, or by analyzing user interaction (e.g., on social networks). However, there are several applications for which high-quality training sets are not easy to be obtained/created. Consider, as an example, a security

scenario where one wants to automatically detect rarely occurring threatening events. In this respect, recently, researchers investigated the possibility of using a visual virtual environment, capable of artificially generating controllable and photo-realistic contents, to create training sets for applications with little available training images. We explored this idea to generate synthetic photo-realistic training sets to train classifiers to recognize the proper use of individual safety equipment (e.g., worker protection helmets, high-visibility vests, ear protection

devices) during risky human activities. Then, we performed domain adaptation to real images by using a very small image data set of real-world photographs.

We show that training with the generated synthetic training set and using the domain adaptation step is an effective solution to address applications for which no training sets exist.

<http://cbmi2019.org/>



Gold medals at the RERS 2019 parallel challenges



Franco Mazzanti (ISTI-FMT) and Frédéric Lang (CONVECS, Grenoble, France) recently won all gold medals for the “Parallel CTL” and “Parallel LTL” tracks of the RERS 2019 challenge. The RERS (Rigorous Examination of Reactive Systems) challenge is an international software competition held every year since 2011. RERS 2019 is the 9th edition of the challenge, and it took place within ETAPS, the primary European forum for software science, as part of the TOOLympics series of software competitions organized to celebrate the 25th anniversary of the prestigious conference on Tools and Algorithms for the Construc-

tion and Analysis of Systems (TACAS). RERS 2019 featured several tracks covering sequential, parallel, and industrial problems. Each track provided a wealth of problems of increasing complexity, the most involved of which are expected to be beyond any individual state-of-the-art method or tool. The goal of the “Parallel CTL” track was to verify 180 properties expressed in the branching-time temporal logic CTL. These properties had to be evaluated on various complex systems, having up to 70 concurrent processes and 234 synchronization actions. Similarly, the goal of the “Parallel LTL” track was to verify, on the same complex systems, 180 properties expressed in the linear-time temporal

logic LTL. Participants were given a period of only three weeks, starting from the publication of the RERS problems on the RERS web site, to compute and submit their answers. To attack such difficult problems, Lang and Mazzanti, who had never met before, decided to join forces, and together they managed to evaluate all the 360 CTL and LTL properties correctly. To this aim, they designed new verification algorithms and reused the compositional verification techniques implemented in the CADP toolbox developed by CONVECS, together with additional software tools, such as KandISTI developed by Mazzanti at FMT, to cross-check some of the results provided by CADP. While the RERS challenge allows the participants to use all possible computing facilities, including supercomputers, the clever use of compositional verification techniques by Lang and Mazzanti enabled all problems to be solved in about 10 hours on a standard laptop.



The picture was taken during the award ceremony organized in Prague (Czech Republic) on April 6th, 2019. From left to right: Malte Mues, Franco Mazzanti, Frédéric Lang, Bernhard Steffen, and Falk Howar.



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Indoor positioning indoor navigation

Tenth International Conference on Indoor Positioning and Indoor Navigation
Pisa, 30 September - 3 October 2019



The tenth edition of the International Conference on Indoor Positioning and Indoor Navigation and the sixth IPIN Competition was held in Pisa, Italy. Launched in 2010 in Zurich, Switzerland, IPIN is a unique event entirely dedicated to indoor localization, its applications, and its development.

The last ten years have seen enormous technical progress in this field, yet, in contrast with outdoor well-established GNSS (Global Navigation Satellite System) solutions, there is as yet no technology cheap and accurate enough for the general market. The potential applications of indoor localization are all-encompassing, from at-home to large public areas, from IoT and personal devices to surveillance and crowd behavior applications, from casual use to mission-critical systems.

IPIN 2019 received 153 contributions as Regular and 24 as Work-in-Progress (WiP) papers. After the review process, 82 papers were accepted for oral presentation and sub-

mission to the IEEE Xplore Digital Library, while 63 were accepted as WiP for poster presentation and submission to CEUR-WS.org (indexed by Scopus, Ei Compendex and DBLP). Selected WiP papers were orally presented during the parallel sessions.

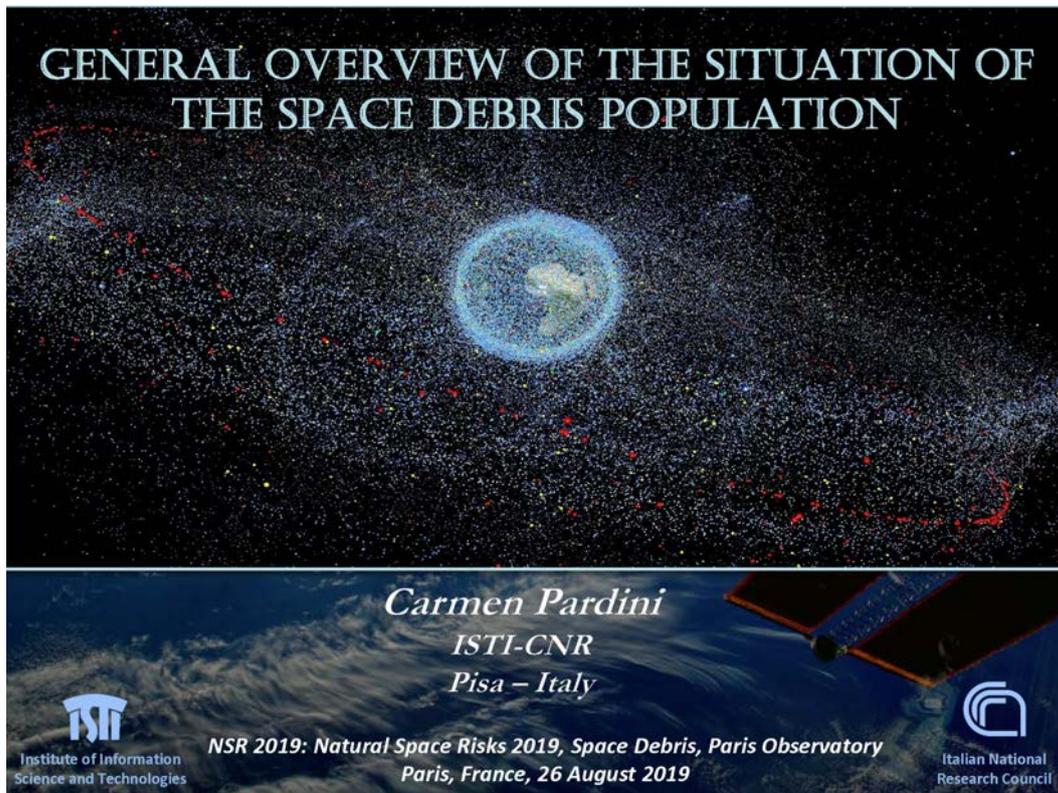
IPIN 2019 hosted 15 competitors for the 2 on-site Competition Tracks and 25 competitors for the 3 off-site Tracks; a Tutorial, a Workshop, three Keynotes from renowned experts and 21 Parallel Sessions plus two Special Sessions made up the scientific content of the conference. Authors had the opportunity to submit extended versions of their papers for review to the MDPI Sensors special issue "Sensors and Sensing Technologies for Indoor Positioning and Indoor Navigation" and to an IPIN special peer-reviewed track of Springer's Journal of Reliable Intelligent Environment.

Technical sponsors are IEEE and several IEEE Societies, Sections, and Chapters. Prizes were awarded for Best Paper, Best

Student Paper, Best Poster and winners of the 5 competition Tracks, thanks to financial sponsorship by several companies. All the local organizers were with CNR, the Italian National Research Council.

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Lecture on space debris at the summer school on natural space risks



Carmen Pardini, a researcher of the Space Flight Dynamics Laboratory since mid-1980s, was invited lecturer at the International Summer School on Natural Space Risks, held at the Astronomical Observatory of Paris, from August 26 to August 31, 2019. This summer school aimed at providing graduate students with intensive training on natural space risks. The program addressed space weather, space debris, near-Earth objects, and their societal impacts.

The lecture by Pardini was titled: "General Overview of the Situation of the Space Debris Population."

Since the beginning of the space age in 1957, almost 5400 successful launches and more than 300 on-orbit breakups have led to nearly 44,000 manmade objects tracked in space. Of these, about 24,000 are currently in orbit, and more than 19,000 are included in the official catalog of the US Space Surveillance Network (SSN).

More than 1800 satellites are operational (Satellite Database of the Union of Concerned Scientists), corresponding to just less than 8% of the on-orbit tracked objects. The remaining are non-functional intact objects (~28%) and debris (~64%). Most of the latter were generated by more than 260 on-orbit fragmentation events recorded since the explosion of the Transit 4A rocket body, on 29 June 1961. The majority of these were explosions, and only a few were collisions, accounting for less than 10 accidental and intentional events. So far, four accidental hypervelocity collisions between cataloged objects have been recorded in Low Earth Orbit (LEO). Three were debris-intact impacts, generating very few cataloged fragments, while one involved the collision, in February 2009, between two intact spacecraft (Cosmos 2251 and Iridium 33), one of which maneuverable, with the consequent production of more than 2290 cataloged fragments.

The intentional breakup of the Chinese

spacecraft Fengyun-1C, in January 2007, led instead to the generation of approximately 3440 cataloged fragments. At present, the outcomes of both collisional events account for nearly 35% of the on-orbit cataloged fragments and boost by about 22% the cataloged population. On-orbit fragmentation events generated the highest number of particles larger than 1 cm: in the order of 750,000, according to ESA's MASTER model. Other sources of space debris, in the centimeter range, have been the slag particles from solid rocket motors, and the sodium-potassium droplets released from Soviet orbital nuclear reactors. The mass of debris in orbit around the Earth is currently approximately 8140 metric tons. Most of the orbiting mass (~98%) is concentrated in intact payloads and upper stages, and nearly 32% resides in LEO (ESA's DISCOS Database). Among the intact objects, nearly 80% are abandoned, and more than 90% cannot be maneuvered. Those left above around 650 km, i.e. with a typical residual lifetime of more than 25 years, represent the main po-

tential mass reservoir for the generation of new detrimental orbital debris in the event of mutual collisions with the existing debris environment.

Since the 1980's, several mitigation measures have been promoted and agreed internationally in order to prevent the occurrence of new breakups in space and put under control the accumulation of the mass of debris abandoned in orbit, but unfortunately the level of compliance with such guidelines, requirements or standards is still far from satisfactory. Moreover, space debris mitiga-

tion alone cannot stabilize the environment, but should probably be complemented by space debris remediation measures.

The lecture first gave a state-of-the-art representation of the population of manmade space objects orbiting around the Earth, from LEO to GEO (geosynchronous orbit), by highlighting both the main sources of orbital debris, together with the principal natural mechanisms (sinks) affecting their orbital evolution. Then, following a short overview of some recent results concerning the debris environment forecast, proposed

mitigation and remediation measures were presented and discussed.

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Telling the story of Armenian manuscripts

Three Armenian manuscripts from Florence dating back to the 13th and 14th centuries are now on display at the Matenadaran Museum in Yerevan thanks to the efforts of the Italian Embassy and the Italian National Research Council (CNR). The exhibition is a perfect mix of science, art, history, and technology, and, thanks to spearheading techniques developed by ISTI-CNR, it is possible to appreciate the craftsmanship and richness of the message contained in the Armenian codes.

These manuscripts were kept in Italy for centuries and more recently in Florence, and are now on show at the Matenadaran

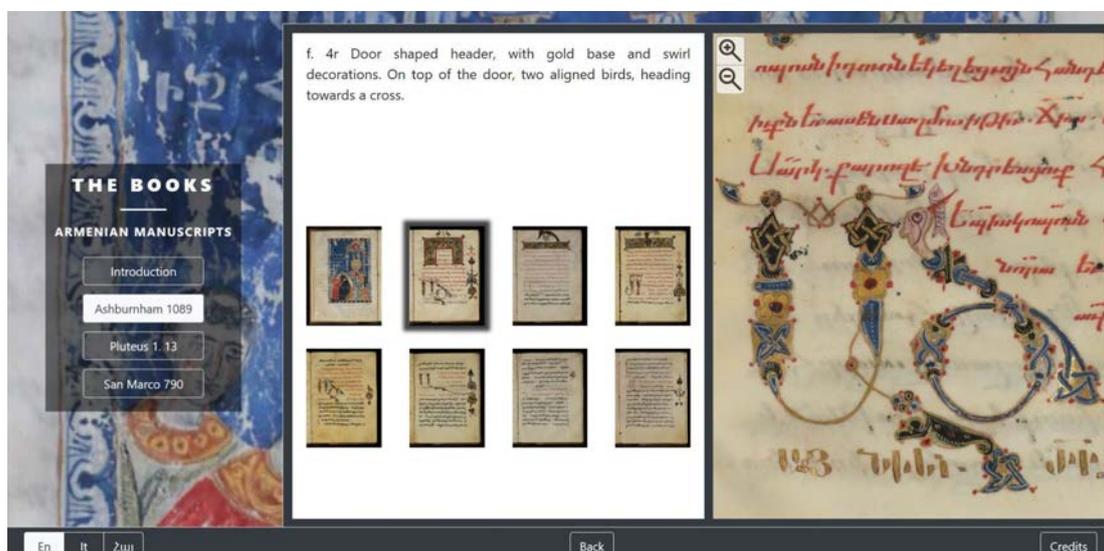
Museum, the temple of Armenian memory and culture.

The story of the journey through the centuries of these manuscripts and the cultural reasons that motivated the exposition in Yerevan have been studied and narrated by Anna Rita Fantoni, the director of the Biblioteca Medicea Laurenziana – the magnificent Michelangelesque building where these manuscripts are conserved – and Giovanna Rasario, former deputy director of the San Marco Library where two of these manuscripts are kept. Their work was the basis for the design and implementation of an interactive multimedia

presentation now on show both in the Matenadaran Museum and on the web (<http://vcg.isti.cnr.it/activities/armenia/>). Local and remote visitors may browse through the pages of the manuscripts, visualizing text and illustrations, explore the library halls that hosted the codices, and consult the explanatory notes through an intuitive touch interface. The system was built using ISTI-CNR platform “3DHOP” (<http://3Dhop.net>).

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Fifty years of computer music in Pisa

Historically, computer music has been an important application of computer science, electronic engineering and information theory.

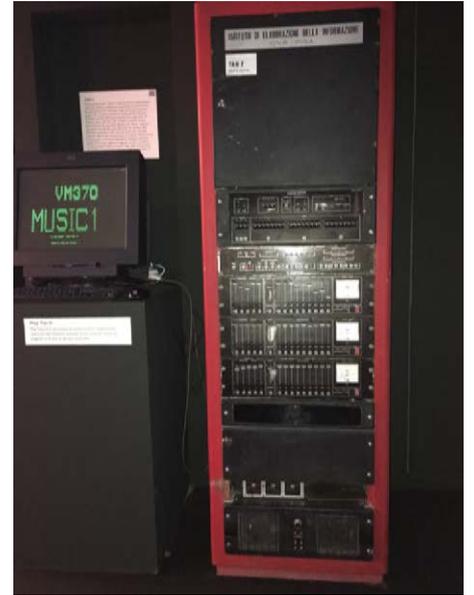
The TAU2-TAUMUS system was selected as a case study and example of the preservation of both hardware and software (1970-1990). TAUMUS was developed in FORTRAN as the music composition environment for controlling the audio terminal TAU2, entirely created at IEI-CNR in Pisa. TAU2 was the first Italian music synthesizer working under the control of a computer (time-sharing family IBM 360/370). TAUMUS is small enough to provide a good benchmark for the Software Heritage project promoted by UNESCO with the goal of collecting and preserving a listing of programs developed in the early days of computer science.

Documentation regarding the system was provided by Leonello Tarabella and Graziano Bertini as part of the archive they maintained at CNR; this material was moved to the Museum of Computing Machinery in Pisa, and all the items were catalogued. The TAU2 machine (still in existence) will be

placed on permanent exhibition at the Museum of Computing Machinery in Pisa.

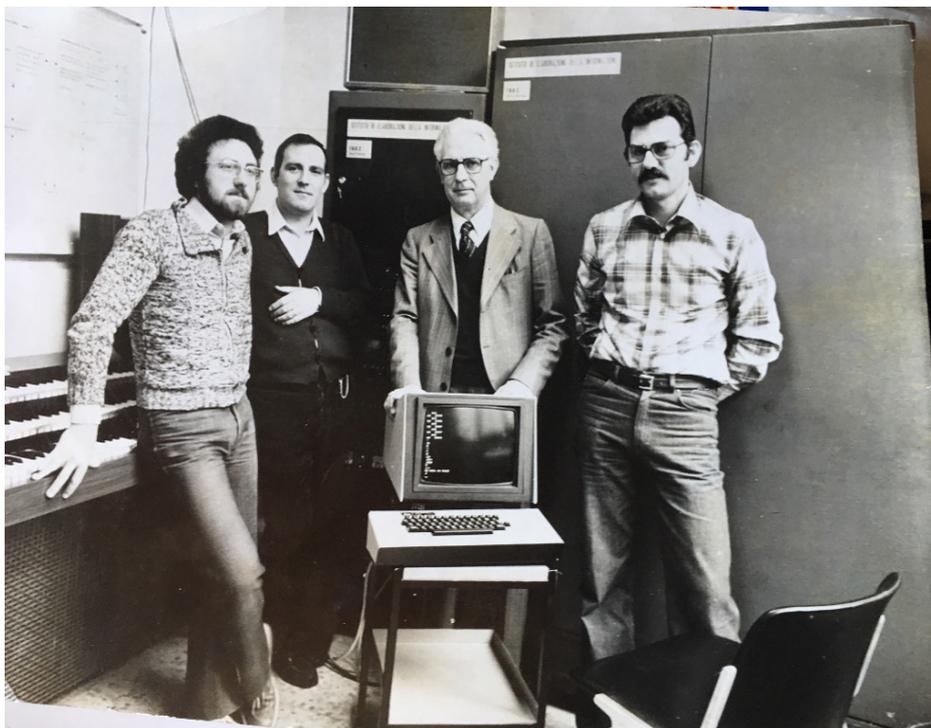
The exhibit also features an interactive application created by Massimo Magrini, researcher at the ISTI Signals and Images Lab, which mimics some basic functionalities of the original TAU2-TAUMUS system, using an alphanumeric video monitor from the 1980s and original recordings from TAU2.

On November 6, 2019, a panel and an exhibition about the story of computer music spearheaded by Maestro Grossi took place at the Conference Centre "Le Benedettine" in Pisa. A special publication about this extraordinary adventure pioneered by Maestro Grossi has been prepared by Leonello Tarabella and Graziano Bertini and edited by Carlo Raffaelli and Luca Doni: "L'Informatica musicale a Pisa, l'esperienza di Pietro Grossi" (Pisa University Press, ISBN 978-88-6741-303-4).



TAU2 demonstrator at the exhibit "Hello World!" (Centro Congressi Le Benedettine, Pisa - until April 30, 2020)

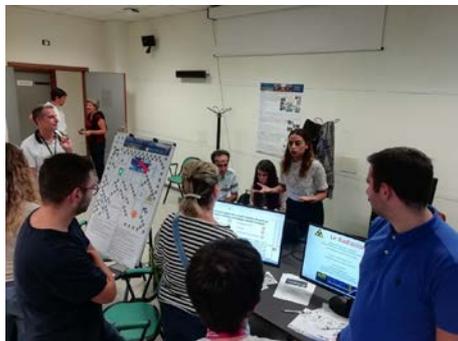
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From left to right: Leonello Tarabella, Massimo Chimenti, Pietro Grossi and Graziano Bertini

General knowledge of radiation protection and dosage in main radiological procedures

A survey of over 2500 people reveals that there is still much to do to raise awareness on this important topic



Over the years, we have witnessed a gradual renewal in the equipment used in various radiological procedures and a general evolution in investigation techniques. Methods and technologies for radiological image processing diagnostics have become an indispensable tool for defining the correct therapeutic pathway for patients. Nevertheless, the available data indicates that about 30% of investigations performed daily do not meet diagnostic appropriateness criteria, thus exposing the patient to unjustified risk. The most recent provisions

on radiation protection by the European Union are reported in Directive 59/2013 / EURATOM which establishes basic safety standards with reference to exposure to ionizing radiation. A study involving ISTI-CNR, IFC-CNR, Doseteam4you, and fourteen clinical centers in Italy aims at a better understanding of the degree of knowledge of the general population about the above topics and a Web platform has been developed to help professionals to conduct a survey in this field. At the moment, data from over 2500 people has been collected. Moreover, during "BRIGHT: The Night of Researchers 2019" M. Martinelli (ISTI), L. Bastiani (IFC) and F. Paolicchi (AOUP) organized a quiz game and a crossword puzzle to promote better knowledge and awareness on this issue. Preliminary results show that 45.8% of the subjects are not aware that a natural source of ionizing radiation exists.

28.8% of the interviewed sample believe that a CT scan does not comport exposure to ionizing radiation. Only 36.8% of the subjects are aware that mammography is a diagnostic test that emits ionizing radiation (43.5% considering only females). Without considering gender differences, 13.4% and 56.2% respectively declare that ultrasounds and MRIs are tests that emit ionizing radiation. 55.1% of respondents say they have not been informed about the risks associated with the use of ionizing radiation with respect to an examination. In conclusion, although the Italian sample population has some basic knowledge of the issues related to radiation protection and radiant dosage, some important gaps remain.

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Conoscenze Popolazione Radiazioni



Login

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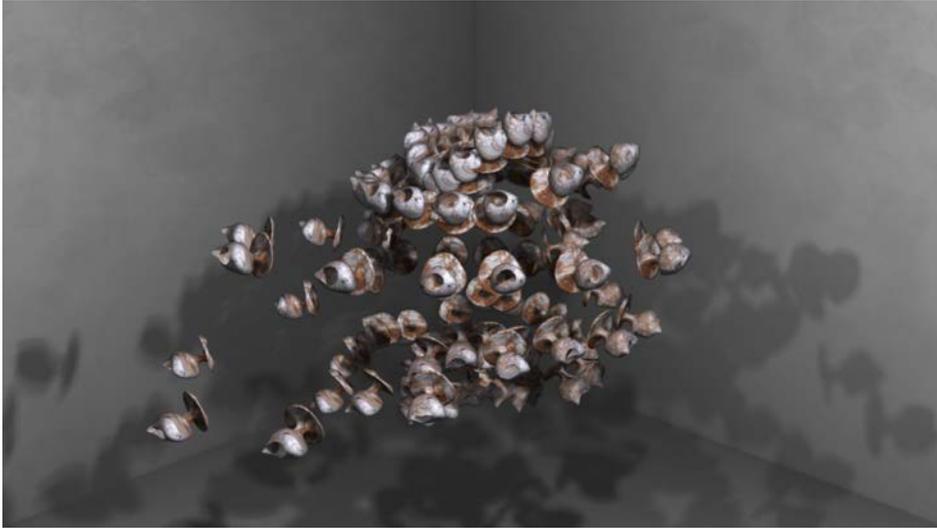
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Realizzato dal Consiglio Nazionale delle Ricerche
Istituto di Scienza e Tecnologie dell'Informazione, Istituto di Fisiologia Clinica
e Doseteam4you



Alma artis and ISTI collaboration

The Signals and Images Laboratory has recently signed a collaboration agreement with Alma Artis, Academy of Fine Arts of Pisa.



Screenshots from the HeartBeat Piano interactive videos

The application of computer science to the arts, both for museum installations and for performing works, has a long tradition in the SI Lab of ISTI.

During the '70s and '80s, a group of researchers from CNUCE and IEI (later merged into the SI Lab of ISTI) collaborated with Maestro Pietro Grossi, a pioneer of Computer Music, on the design and development of the vari-

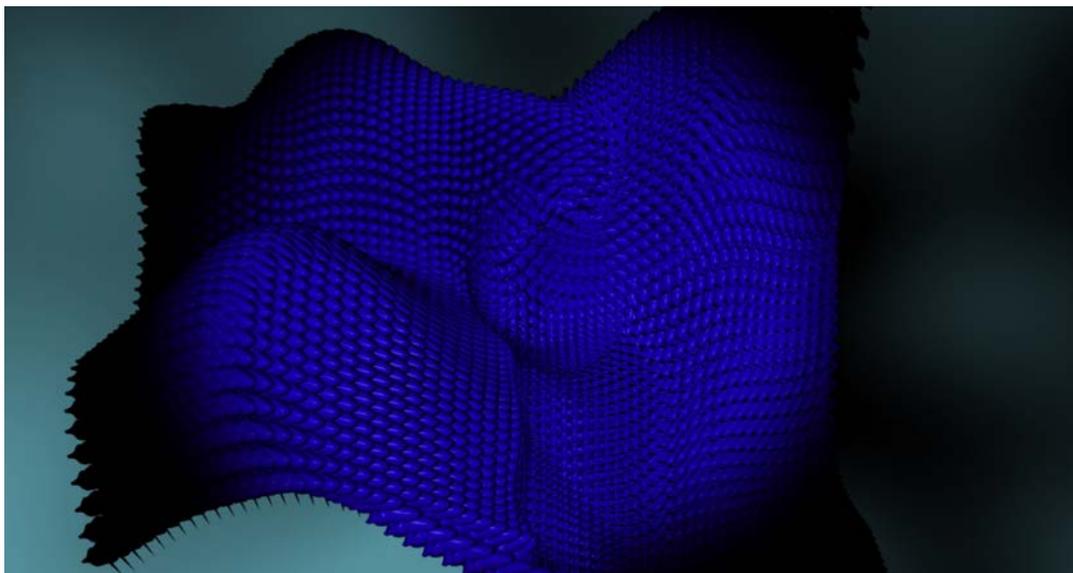
ous TAU music terminals / TAUMUS. Later on, these seminal experiments evolved into the development of complex systems to control music and graphics in real time, often using special gestural control systems.

Given this experience, it was natural to start a collaboration with the Alma Artis Academy, based in Pisa. This academy is the primary local centre for advanced train-

ing, specialization, research and artistic design. Alma Artis carries out artistic training activities with the aim of developing a relationship between art, science and new technologies. The collaboration aims at promoting a didactic and research activity that includes both lectures and the preparation of theses, and the joint development of prototypes of museum installations or performances based on human-machine interaction. In 2019, the collaboration with SI Lab produced two interesting activities presented as theses. The first named "Heart Beat Piano Project", by Paolo Kosmas, is a performance in which a pianist, thanks to the detection of their vital functions (ECG, EEG), controls generative videographics in real time through his emotional state.

The second "Explore Kandisky" by Anna Dameri, is a virtual VR exhibition in which the "visitor" interacts with abstract paintings, modifying the spatial position of the graphic elements and obtaining their personal spatial variations of the opera.

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Screenshots from the HeartBeat Piano interactive videos

Ph.D. dissertations

Deep learning for image classification and retrieval: analysis and solutions to current limitations

Author: Fabio Carrara, Dipartimento di Ingegneria dell'Informazione, Università di Pisa

Supervisors: Giuseppe Amato, Claudio Gennaro, Francesco Marcelloni

The wide diffusion of cheap cameras and smartphones has led to an exponential daily production of digital visual data, such as images and videos. In this context, most of the data produced lack the manually assigned metadata, important for their manageability in large-scale scenarios, thus shifting attention to the automatic understanding of the visual content. Recent developments in Computer Vision and Artificial Intelligence have empowered machines with high-level vision perception enabling the automatic extraction of high-quality information from raw visual data. Specifically, Convolutional Neural Networks (CNNs) have provided a way to automatically learn effective representations of images and other visual data, showing impressive results in vision-based tasks, such as image recognition and retrieval. In this thesis, we investigated and enhanced

the usability of CNNs for visual data management. First, we identified three main limitations encountered in the adoption of CNNs and proposed general solutions that we experimentally evaluated in the context of image classification. We proposed miniaturized architectures to decrease the usually high computational cost of CNNs and enable edge inference in low-powered embedded devices. We tackled the problem of manually building huge training sets for models by proposing an automatic pipeline for training classifiers based on cross-media learning and Web-scraped weakly-labeled data. We analyzed the robustness of CNNs representations to out-of-distribution data, specifically the vulnerability to adversarial examples, and proposed a detection method to discard spurious classifications provided by the model. Secondly, we focused

on the integration of CNN-based Content-based Image Retrieval (CBIR) in the most commonly adopted search paradigm, that is, textual search. We investigated solutions to bridge the gap between image search and highly-developed textual search technologies by reusing both the front-end (text-based queries) and the back-end (distributed and scalable inverted indexes). We proposed a cross-modal image retrieval approach which enables textual-based image search on unlabeled collections by learning a mapping from textual to high-level visual representations. Finally, we formalized, improved, and proposed novel surrogate text representations, i.e., text transcriptions of visual representations that can be indexed and retrieved by available textual search engines enabling CBIR without specialized indexes.

Reinforced and post-tensioned structural glass shells: concept, morphogenesis and analysis

Author: Francesco Laccone, Dipartimento di Ingegneria, dei Sistemi, del Territorio e delle Costruzioni, Università di Pisa

Supervisors: Maurizio Froli, Paolo Cignoni

The relationship between architecture and structure is a key point in the conceptual phase of a building or one of its components. Glass structures can be considered optimal from the material usage viewpoint because they simultaneously offer transparency, an idea always pursued by architects, and good structural performance.

Transparent and free-form glass shells are fascinating objects from both the aesthetic and structural engineering point of view, but are practically difficult to realize, apart from limited favorable cases, and have a low

safety level. This work explores a new structural concept for triangulated glass shells, in which the glass panels are both reinforced and post-tensioned. Hence, the net formed by the reinforcements constitutes a redundancy barrier to avoid global collapse in the event of the glass cracking.

In order to ensure an adequate safety level, the glass should be prevented from carrying tensile stresses. For this purpose, a novel algorithm is developed for the automatic design of the piecewise geometry of the shell and the derivation of the optimal cable dis-

tribution with respective pre-loads.

Global nonlinear analyses have been performed to prove the feasibility of the concept and to highlight the advantages that these structures offer with respect to the grid shells competitors. At the local level, the main components of these systems are investigated: the node is tested experimentally, and its behavior is successively described numerically, and the triangular laminated panels are explored with parametric nonlinear models.

Power grid evaluation through efficient stochastic model-based analysis

Author: Giulio Masetti, Dipartimento di Informatica, Università di Pisa

Supervisors: Felicita Di Giandomenico, Marco Danelutto

The electrical infrastructure can be considered nowadays as a meta-critical infrastructure: it is the backbone for almost all the critical infrastructures of a modern nation, such as utilities, water, transportation, public health, finance, security services. Given its highly critical role, it is paramount to ensure its accuracy and efficiency.

To allow pervasive control and monitoring of resilience and performance enhancements, the Smart Grid (SG) is emerging as a convergence between information and communications technology and power system engineering. The effectiveness and ability of the SG to operate in critical scenarios, such as the presence of failures due either to accidental faults or intentional attacks, must be studied. In addition to traditional depend-

ability measures, such as reliability and availability, the voltage quality and the energy required, but not supplied, by the distribution system are also relevant measures for investigation.

The thesis contributes in the direction of promoting efficient evaluation of the SG in realistic scenarios from a resilience perspective.

Specifically, it develops and assesses different approaches to model-based quantitative dependability analysis of smart power distribution grids, in which computing and communication components as well as electrical components are considered. A fault model encompassing both accidental faults (affecting both the electrical grid and its

control system) and intentional attacks (affecting the control system only) is proposed. Major achievements are: (1) development and assessment of a modeling methodology to efficiently handle sparse interdependencies between model components in model generation and model execution; (2) implementation and assessment of different numerical methods for efficient and accurate calculation of electric power-flow equations for alternating-current distribution grids; (3) demonstration of the benefits of the efficiency enhancements in an extended version of a previously developed dependability model for distribution grids based on Stochastic Activity Networks (SANs); (4) assessment of dependability metrics for reference grid scenarios.

Mining human mobility data and social media for smart ride sharing

Author: Monteiro De Lira, Vinicius Cezar, Centro de Informática, Universidade Federal de Pernambuco, Brazil and Dipartimento di Informatica, Università di Pisa, Italy,

Supervisors: Chiara Renso, Rossano Venturini

People living in highly-populated cities increasingly suffer an impoverishment of their quality of life due to pollution and traffic congestion. The reduction in the number of circulating vehicles is one of the most difficult challenges being faced in large metropolitan areas. This doctoral thesis proposes a research contribution aimed at reducing the number of circulating vehicles. On the one hand, we aim to improve the efficacy of ride-sharing systems, creating a larger number of ride possibilities based on passengers' declared destination activities; on the other hand, we propose a social media analysis methodology, based on machine learning, to identify the demand for transport to an event. With respect to the first objective, we investigated a novel approach to boost ride-sharing opportunities based not only on fixed destinations but also on alternative destinations, while preserving the intended

activity of the user. We observed that in many cases the activity motivating the use of a private car (e.g., going to a shopping mall) can be performed at many different locations (e.g., all the shopping malls in a given area). Our assumption was that, when there is the possibility of sharing a ride, people may accept to visit an alternative destination to fulfill their needs. We thus proposed Activity-Based Ride Matching (ABRM), an algorithm aimed at matching ride requests with ride offers to alternative destinations where the intended activity can still be performed. By analyzing two large mobility datasets, we found that with our approach there is an increase up to 54.69% in ride-sharing opportunities compared to a traditional fixed-destination-oriented approach. For the second research contribution, we focused on the analysis of social media to infer transport demands for large events such as

music festivals and sporting activities. In this context, we investigated the novel problem of exploiting the content of non-geotagged posts to infer users' attendance at large events. We identified three temporal periods: before, during and after an event. We detailed the features used to train the event attendance classifiers on the three temporal periods and reported on experiments conducted on two large music festivals in the UK. Our classifiers attained a very high accuracy, with the highest result observed for Creamfields festival (~91% accuracy in classifying users that will participate in the event). Furthermore, we proposed an application of our methodology in event-related transportation. This proposed application aims at estimating those geographic areas with a higher potential demand for transportation services to an event.

Space and time-efficient data structures for massive datasets

Author: Giulio Ermanno Pibiri, Università di Pisa

Supervisor: Rossano Venturini

This thesis discusses the design of compressed data structures for the efficient storage of massive datasets of integer sequences and short strings. As the problems studied arise in several real-world scenarios, such as inverted index engineering, a consistent part of the thesis focuses on the experimental analysis of the solutions presented.

With respect to the problem of representing in compressed space the sorted integer sequences of inverted indexes, three different solutions showing new interesting space/time trade-offs were proposed

The first proposal shows that clustering the inverted lists yields more compact indexes at the expense of a moderate slowdown in query processing speed.

The second proposal describes an optimal, linear-time, algorithm that splits an inverted

list into variable-size partitions in order to minimize its space when the Variable-Byte encoding is used to compress its partitions.

The third proposal exploits the repetitiveness of the d-gapped inverted lists to achieve compact storage and very fast decoding speed. Specifically, we show that a dictionary of repeated integer patterns can be built to compress the inverted lists. This makes it possible to represent the inverted lists as references to the dictionary's patterns, thus allowing the two-fold advantage of: encoding many integers with a single reference identifier; decoding many integers with a single dictionary access.

We then take into account strings of at most n words, i.e., n -grams and address the two fundamental problems of: indexing large and sparse n -gram datasets; estimating language models from a large textual collection.

For the problem of indexing, we introduce a compressed trie data structure where the identifier of a word appearing after a context of k preceding words is represented as an integer whose value is proportional to the number of words that can follow such a sequence. For the problem of estimation, we design a novel algorithm for estimating Kneser-Ney language models in external memory.

From a theoretical perspective, we also study the fascinating problem of representing dynamic integer dictionaries in succinct space. We describe a data structure that matches the optimal time bounds for the operations and, at the same time, achieves almost optimal compressed space by resorting to the succinctness of the Elias-Fano integer encoding.

Interaction and rendering with harvested 3D data

Author: Manuele Sabbadin, Dipartimento di Informatica, Università di Pisa

Supervisors: Gianpaolo Palma, Paolo Cignoni

There is currently great interest in the Computer Graphics community in 3D scanning technologies based on active and passive solutions. The market offers several generally affordable, low-cost devices and software. This means that even users with limited technical knowledge and expertise are easily able to acquire almost any object or environment. The acquisition output is complex 3D data, usually point clouds, that encodes not only spatial and visual information but also the output radiance of each sample point. This data is used for different purposes, from simple visualization to more complex processing for the computation of dense triangular models, or to infer additional semantic information. Even if these devices have been present on the market for

some years and are now well established, so far little attention has been given to interaction with this noisy data, both with respect to colour and geometry, and also to the use of all input attributes in real-time rendering to approximate global illumination effects.

The goal of this thesis is to address these problems and to propose new algorithms to render and interact with raw harvested 3D data. The thesis makes four main contributions. The first is a new algorithm for interaction with temporal 3D data, where the same scene is acquired multiple times in different moments, improving the visualization and perception of the most significant geometric changes, and limiting the perceptual impact of noisy data. The second contri-

bution is a new method to approximate the global illumination effects in a point cloud using the ambient occlusion, by proposing an algorithm tailored specifically for point clouds when the traditional approach is not effective. The third contribution is a simple algorithm to expand the dynamic range of the colour data of a Low Dynamic Range point cloud, the usual output of the low-cost devices, using a single High Dynamic Range (HDR) photo of the same scene. The last contribution is a new Point-Based Global Illumination algorithm that, taking in input an HDR point cloud expanded with the previous method, can compute in real-time the relighting of a virtual object placed inside the cloud.

Welcome aboard!



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FMT Lab



Antonino Crivello
Research Staff (Tecnologo)
WN Lab



Valerio Grossi
Research Staff (Tecnologo)
KDD Lab



Andrea Mannocci
Research Staff (Ricercatore)
NeMIS Lab



Fabio Mavilia
Research Staff (Tecnologo)
WN Lab



Salvatore Trani
Research Staff (Ricercatore)
HPC Lab

Conferences - Co-organized by ISTI



IUI 2020 – 25th International Conference on Human Computer Interaction.

Cagliari , Italy March 17-20, 2020

<http://iui.acm.org/2020/>



REFSQ2020 – 26th International Working Conference on Requirements Engineering:

Foundation for Software Quality Pisa , Italy March 24-27, 2020

<https://refsq.org/welcome>



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