ISTI NEWS

CNR plays a leading role in shaping the future of AI in Italy and in Europe

Artificial Intelligence (AI) is considered the 21st century's most strategic technology, impacting society and industry, much as the steam engine or electricity in the past. Over the last decade, AI-based solutions have pervasively permeated our daily life, helping us to optimise logistics and supply chains, better diagnose diseases, fully tailor re- commendations to specific tastes or needs, and better understand societal phnomena. Together with other digital technologies, it could be claimed that AI is enabling a "fifth element": a data-exploiting element, by grad- ually virtualizing our environment and mul- tiplying our possibilities as human beings. [Continues on page 4]

Open-AIRE-Advance

Co-funded by Horizon 2020

OpenAIRE-Advance continues the mission of OpenAIRE to support the Open Access/ Open Data mandates in Europe, by sus- taining the current successful infrastruc- ture, comprised of a human network and robust technical services, the activity is con- solidating the achievements obtained so far while working to shift the momentum among its communities towards Open Science. [page 6]

Speleonotte 2018

October 13, 2018, Castellana Grotte, Italy

In the Castellana caves (Bari), during the Speleonotte 2018, meeting Massimo Magri- ni presented his sound art project "Olhon". [page 53]

Editorial

A new Director for ISTI

After a somewhat lengthy selec- tion process, finalized in Febru- ary 2019, I officially began my four-year term as Director of ISTI on 1 April 2019. April Fools Day as some of my colleagues were kind enough to point out! My first words are for Claudio Montani, the previous Direc- tor, to whom I would like to express my sincere thanks and gratitude for the great results achieved by ISTI under his di- rection.

National Research Council of Italy

Contents

A new Director for ISTI

Roberto Scopigno introduces himself and talks about how it feels to take over as the Director of the Institute in which he has spent many happy and fruitful years as a researcher

[Continued]

Claudio led our Institute for a total of 12 years, with 2 official terms as Director and some periods as acting-director in-between. This coincided with some critical and not easy years at CNR with major changes at the management level (Claudio had to interact with six CNR Presidents, six Heads of Department and four General Managers) as well as major innovations at the administrative level (with new procedures and regulations which did not always co-exist easily with international research rules and policies). However, despite some considerable bureaucratic challenges, Claudio leaves a very healthy institute, with a strong scientific visibility, a solid financial status (thanks to the large number of research projects awarded to ISTI Labs) and excellent internal administrative services.

So, let me say that I feel very proud but at the same time slightly intimidated in taking on the leadership of ISTI and following in Claudio's very successful footsteps. Luckily for me, I am very well acquainted both with this Institute and with CNR as a whole as I have passed my entire working life as a researcher here, first at CNUCE and then at ISTI, where I led the Visual Computing Lab. So I know both the Institute and the Institu-tion very well and I appreciate this opportunity to change the focus of my activity, from leading a research lab to leading a CNR institute. I am conscious that this implies much less hands-on science and much more administration and bureaucracy but I feel ready and willing to meet the challenges. My objective is that ISTI plays an even more brilliant and dynamic role in national and international research activities, and in order to achieve this I see my task as working closely with our central administration in Rome while at the same time following research trends and related ISTI activities and results. Scientific research is most of all international and thus must be managed by taking the international context in due consideration (this also means trying to steer our central administration towards international standards and rules). I hope not to become too dizzy in this attempt to achieve compatibility and interoperability between two very different sets of norms and procedures.

I would like to thank the President of CNR and the Director of the Department for Engineering, ICT and Technologies for Energy and Trasportation (DITET) for giving me the opportunity to take on this role, and I must also express my gratitude to the entire staff of ISTI for the many good wishes and expressions of encouragement that I have received. I will do my best not to disappoint them over the coming years.

As usual, the aim of ISTI News is to provide a survey of the latest projects, research activities, software delivered and other achievements of the Institute. The lead article by Colantonio et al. concerns ISTI's role and activities in AI technologies, an area in which the Institute aims at playing a key role in Italy and Europe.

I am also very happy to mention that in 2018 we had a record number people taking up tenure positions. You can see their photos at the end of this issue. In most cases these people are not just new members of the staff, but colleagues who have built up their CVs and careers working with us for many years. We are delighted to welcome them in a more stable position at ISTI!

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CNR plays a leading role in shaping the future of AI in Italy and in Europe

[Continued]

Three main drivers can be identified behind today's renewed flourishing of AI: stronger computational power; more sophisticated machine learning algorithms; and higher availability of vast amounts of exploitable data. The conjunction of these factors has generated important benefits both for individuals and for society as a whole, and promises to address or even solve the grand challenges, such as climate change or global health and wellbeing.

However, the significance of the positive impact of AI is partially clouded by the shadows cast by its potential threat to economic and social life. For this reason, governments around the world are now deploying strategic plans with comprehensive policy programmes, research activities and financial support for private investment in the AI domain. The aim is to support and promote AI initiatives by creating favourable regulatory environments and establishing global standards and best practices, in order to ensure that all AI-based technologies provide added-value for society and that this value is shared as widely as possible. This is what is currently happening in Italy and in Europe, with CNR playing a central role within this framework.

At the national level, CNR has a key part in three initiatives:
- the Working Group on AI of the Italian Ministry for University and Research
- the CNR Virtual Laboratory
- the Artificial Intelligence and Intelligent Systems (AIIS) laboratory of the Italian National Inter-university Consortium for Informatics (CINI).

In particular, CNR is leading the recently established ministerial Working Group on AI. This group has the goal of defining a long-term national strategy for integrating the diverse Italian expertise in AI and developing a national program of PhD courses.

The working group has defined five main areas:
- AI and Data Science
- AI and Cyber Security
- AI for Health and Life Science
- AI for Industry 4.0
- AI for Environment and Agriculture

CNR has also established a national Virtual Laboratory with the objective of linking all the researchers working on AI throughout its various departments and institutes and encouraging collaboration. ISTI is participating in this Virtual Laboratory with the following research groups: AI for Multimedia Information Retrieval, Knowledge Discovery and Data Mining Laboratory, Signal & Images Laboratory, Human Interfaces in Information Systems, High Performance Computing, Dependable and Secure Computing, Visual Computing, Wireless Networks, System and Software Evaluation, Semantic Web, Digital Libraries, InfraScience - Ecological Modelling, Human Language Technologies.

In July 2018, CINI launched the "Artificial Intelligence and Intelligent Systems" Lab, with the goal of integrating ongoing activities in Italian Universities and Research Institutes. Fosca Giannotti from ISTI-CNR is a member of the steering committee and CNR participates with two nodes: one for the Department of Engineering, ICT and Technology for Energy and Transport (DIITET) and one for the Department of Humanities and Social Sciences, Cultural Heritage (DSU). Recently, the CINI AIIS Lab organized a first networking event, Ital-IA, held in Rome last March. CNR researchers were present with 60 contributions. At the international level, ISTI is a key partner in important European initiatives on AI, namely two H2020 projects that started in 2019 aimed at shaping the European path to Artificial Intelligence. The first "A European AI On Demand Platform and Ecosystem" is a consortium of 80 partners and is aimed at building a compre-

hensive European AI-on-demand platform to lower barriers to innovation, to boost technology transfer and to catalyse the growth of start-ups and SMEs in all sectors of AI through Open Calls and other actions. The KDD and NEMIS Labs of ISTI will contribute to the research and innovation efforts of this projects in order to fill important technology gaps. The second, a Humane-AI preparatory action for Flagship-like research visions, is a coordination action that involves 35 partners including ISTI's KDD Lab, and is aimed at setting up a road map to build the scientific foundations and achieve the technological breakthroughs needed to shape the AI revolution in a direction that is beneficial to humans on both individual and societal levels and that adheres to European ethical values and social, cultural and political 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.

Last, but not least, ISTI has recently been awarded an Advanced Grant of the European Research Council for a project on "Science and technology for the explanation of AI decision making" (XAI). Explanation is at the heart of a responsible, human-centric AI, across multiple industry sectors and scientific disciplines. The last decade has witnessed the rise of a black box society. Ubiquitous obscure algorithms, often based on sophisticated machine learning models trained on (big) data, which predict behavioural traits of individuals, such as credit risk, health status, personality profile. Black boxes map user features into a class or a score without explaining why, because the decision model is either not comprehensible to stakeholders, or secret. This is worrying not only in terms of the lack of transparency, but also due to the possible biases hidden in the algorithms.

Machine learning (ML) constructs predictive models and decision-making systems based on (possibly big) data, i.e., the digital traces of human activities (opinions, movements, lifestyles, etc.). Consequently, these models may reflect human biases and prejudices, as well as collection artifacts and sample selection biases, possibly leading to unfair or simply wrong decisions. Many controversial cases have already highlighted that delegating decision-making to black box algorithms is critical in many sensitive domains, including crime prediction, personality scoring, image classification, personal assistance. We are evolving faster than expected from a time when humans are coding algorithms and carry responsibility of the resulting software quality and correctness, to a time when machine automatically learn algo-rithms from sufficiently many examples of the algorithms' expected input/output behavior.

It is not surprising that the key enabling Industry 4.0 is committed to paying attention to the quality of life, and the health and safety of industrial workers and others involved in organized activities. The noteworthy proliferation of sensing technologies and IoT in sports has attracted the attention of the scientific community. At ISTI, models based on machine learning techniques have been studied to predict the probability of players being injured during their next training sessions, given their recent workloads. These models can also be ported to the factory in order to foster the creation of safer environments.

A missing validation step in the construction of a machine learning model is precisely the explanation of its logic, expressed in a comprehensible, human-readable format, that highlights the biases learned by the model, assessing their plausibility. XAI is aimed at filling this gap, developing theory and technology for explainable AI at the convergence of learning, reasoning and statistical mechanics.

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OpenAIRE-Advance

OpenAIRE advancing open scholarship
Co-funded by Horizon 2020

OpenAIRE-Advance continues the mission of OpenAIRE to support the Open Access/ Open Data mandates in Europe. By sustaining the current successful infrastructure, comprised of a human network and robust technical services, the activity is consolidating the achievements obtained so far while working to shift the momentum among its communities towards Open Science.

The objective is to be a trusted e-Infrastructure within the realms of the European Open Science Cloud. In this phase, OpenAIRE-Advance is striving to empower its National Open Access Desks (NOADs) to become a pivotal part within their own national data infrastructures, positioning OA and open science onto national agendas.

The capacity building activities bring together experts on topical task groups in thematic areas (open policies, research data management, legal issues, test data man-

agement), promoting a "train the trainer" approach, strengthening and expanding the pan-European Helpdesk with support and training toolkits, training resources and workshops.

Key elements of scholarly communication are being examined, i.e., co-operative OA publishing and next generation repositories, to develop essential building blocks of the scholarly commons.

On the technical level, OpenAIRE-Advance focuses on the operation and maintenance of the OpenAIRE technical services, and is radically improving the OpenAIRE services on offer by: a) optimizing their performance and scalability, b) refining their functionality based on end-user feedback, c) repackaging them into products, taking a profession-

al marketing approach with well-defined Key Performance Indicators, d) consolidating the range of services/products into a common e-Infra catalogue to enable a wider uptake.

OpenAIREAdvance is stepping up its outreach activities through concrete pilots with three major Research Infrastructures, citizen science initiatives, and innovators via a rigorous Open Innovation programme. Finally, via its partnership with COAR (Confederation of Open Access Repositories).

OpenAIRE-Advance consolidates OpenAIRE's global role extending its collaborations with Latin America, US, Japan, Canada, and Africa.

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RDA Europe 4.0

The European plug-in to the global Research Data Alliance
Co-funded by Horizon 2020

The UPP-02-2017 call targeted the area "European support to the Research Data Alliance, RDA" designing Europe's contribution to the implementation of an effective governance model and strategy in global RDA, while ensuring that RDA delivers on locally relevant issues. RDA Europe 4.0 focuses on the need for open and interoperable sharing of research data and on the need to build social, technical and cross-disciplinary links to enable such sharing on a global scale.

It aims to do this with the community-driven and bottom-up approach launched in 2012. In fact, RDA Europe 4.0 directly builds on the current RDA Europe effort, by efficiently

bringing in the organizations that have been employed in implementing RDA Europe since 2012.

The scope of RDA Europe 4.0 is to become the centerpiece for an EU Open Science Strategy through a consolidated European network of National Nodes, bringing forward an RDA legacy in Europe, providing skilled, voluntary resources from the EU investment to address DSM (Distributed

Shared Memory) issues, by means also of an open cascading grant process.

The ambitious, 27-month project is implemented by 5 European partners, skillfully supported by 9 National Nodes which carry out specific operational activities and act as national contact points for their respective region. In this context, ISTI-CNR will act as the Italian National Node. One of the specific goals of RDA Europe 4.0 is to complete a capillary European network by including 13 additional nodes by the end of the project.

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BigDataGrapes

Big Data to enable global disruption of the grapevine-powered industries
Co-funded by Horizon 2020

In recent years, big data in agricultural and food research has received considerable attention. As farms are increasingly equipped with smart machines and sensors and farm data grow in quantity and scope, farming processes are progressively becoming data-driven and data-enabled. This is leading to new agricultural management processes and new challenges and opportunities for informed decision making from the micro (i.e. precision agriculture) to the macro scale (i.e. policy making).

The BigDataGrapes project aims at building knowledge and methodologies to support companies in the grapevine industry when making important decisions by exploiting complex and heterogeneous data sources modeled using RDF. Specifically, the proj-

ect addresses critical data-driven problems related to: (a) new wine development, (b) intelligent vineyard management, (b) dynamic food risk vulnerability assessment and (d) intelligent quality assurance & selection of natural extracts and suppliers. The HPC Lab of ISTI-CNR is responsible for providing the consortium with efficient and scalable methods for big data analytics to address the volume and the complexity of the data, with concise and fast data structures for indexing and searching huge RDF repositories, and with robust methodologies for the experimental assessment of the Big-DataGrapes software stack.

The project, which began in January 2018 and will end in December 2020, involves partners working on satellite and weather

data, environmental and geological data, phenotypic and genetic plant data, food supply chain data, economic and financial data, and more. It thus represents an impressive cross-sector and cross-country combination of industries that are of high European significance and value.

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http://www.bigdatagrapes.eu/
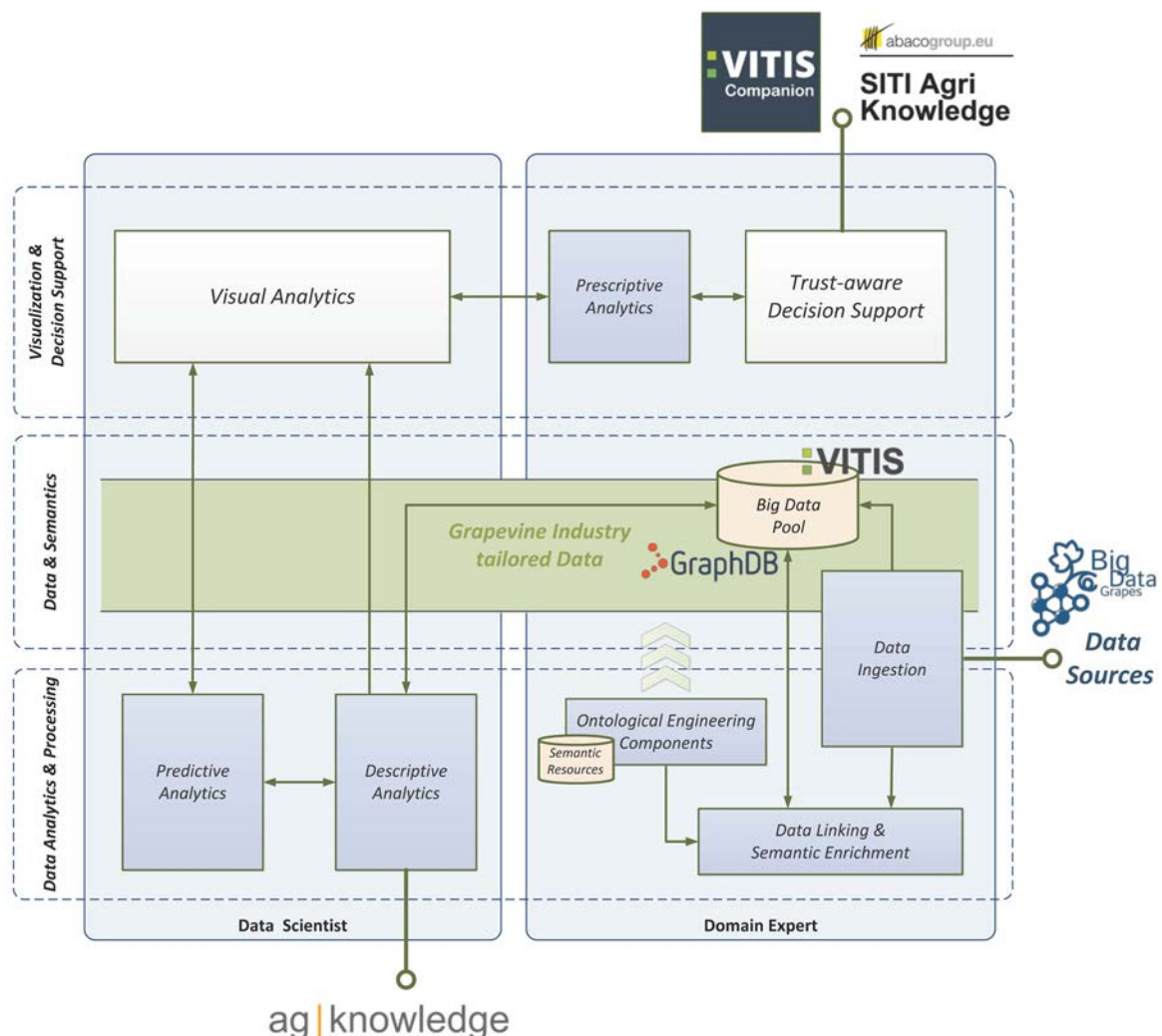
EVOCATION

Advanced visual and geometric computing for 3D capture, display, and fabrication
Co-funded by Horizon 2020

The Evocation project aims to create a leading European-wide doctoral Collegium for research in advanced visual and geometric technologies that target the emerging fields of 3D Capture and Fabrication. This doctoral Collegium will train the next generation of creative, entrepreneurial and innovative experts who will be equipped with the necessary skills and competence to face current and future major challenges in scalable and high-fidelity geometry and mat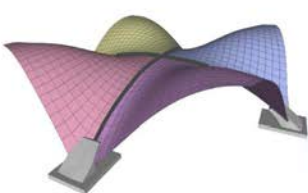erial acquisition, extraction of structure and semantic information, processing, visualization, 3D display and 3D fabrication in professional and consumer applications. ISTI will participate in the project by working on two main themes: 3D acquisition and digital fabrication.

With respect to innovation in visual and geometric acquisition we aim to enable scalable and cost-effective high-fidelity mass-digitization of the shape and appearance of large collections of 3D objects with complex materials going beyond manual acquisition of single objects to the automated multi-modal acquisition of large collections. In fact it is still a challenge to enable fast, scalable, and repeatable capture of large collections and to automatically derive structured and semantically-rich representations.

In addition to fostering innovation in computational fabrication, we envision extending the reproduction capabilities of current 3D printing technologies and processes. The intention is to investigate better computational design approaches able to represent and predict visual and physical properties of real world material in an accurate and reliable manner, leading to improved production pipelines that go from acquisition or design to 3D fabrication in a more predictable and straightforward way. We will also study less explored aspects of the manufacturing pipelines, where human experience and skills are currently necessary for successful fabrication, in order to fully automatize them.
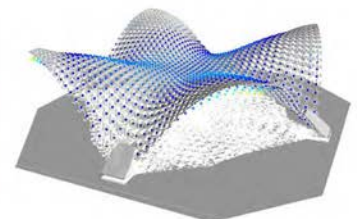
(a)   (b)   (c)   (d)

Track&Know

Big Data for mobility tracking knowledge extraction in urban areas
Co-funded by Horizon 2020

ITrack & Know is a Horizon2020 project, with a focus on Big Data. More specifically, Track & Know is researching, developing and exploiting a new software framework that aims at increasing the efficiency of Big Data. The framework will be applied in the transport, mobility, motor insurance and health sectors.

On the basis of industrial use-cases, Track&Know will develop user friendly toolboxes that will be readily applicable in the markets of interest, and will also be tested in additional domains through liaison activities with running ICT-15 Lighthouse projects.

Track&Know integrates multidisciplinary research teams from Mobility Data Man-

agement, Complex Event Recognition, Geospatial Modelling, Complex Network Analysis, Transportation Engineering and Visual Analytics to develop new models and applications. As Track&Know recognizes that Big Data penetration is not adequately developed in niche markets outside the traditional areas (e.g. Finance), the Track&Know Toolboxes will be demonstrated in three real-world Pilots using datasets from niche market scenarios to validate efficiency improvements. Performance and impact benchmarks will be established and documented during deployment of the pilots.

The Track&Know consortium is composed by complementary partners, coming from relevant research, technological and commercial domains, and with a proven track record of high quality research capacity.

The carefully structured workplan, embodies a holistic approach towards meeting the Track&Know objectives and delivering market-relevant outcomes of significant exploitation potential.

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MINGEI

Representation and preservation of heritage crafts
Co-funded by Horizon 2020

Mingei will explore the possibility of representing and making accessible both tangible and intangible aspects of craft as cultural heritage (CH). Heritage Crafts (HCs) involve craft artefacts, materials, and tools and encompass craftsmanship as a form of Intangible Cultural Heritage. Intangible HC dimensions include dexterity, know-how, and skilled use of tools, as well as tradition, and identity of the communities in which they are, or were, practiced. HCs are part of history and impact the economy of areas in which they flourish. The significance and urgency of the preservation of HCs must be highlighted, as several are threatened with extinction.

Despite their cultural significance efforts for HC representation and preservation are scattered geographically and thematically. Mingei will provide means to establish HC representations based on digital

assets, semantics, existing literature and repositories, as well as mature digitisation and representation technologies. These representations will capture and preserve tangible and intangible dimensions of HCs. Central to craftsmanship is skill and its transmission from master to apprentice. Mingei will capture the motion and tool usage of HC practitioners, from Living Human Treasures and archive documentaries, in order to preserve and illustrate skill and tool manipulation.

The knowledge acquired will be disseminated through compelling presentations, using storytelling and educational applications and based on Augmented Reality and the Internet. It is known that engaging cultural experiences have a positive impact on the growth of interest and on tourism, and this in turn will help to support HC communities and institutions and foster HC sustainability and

preservation.

The Mingei consortium brings together complementary expertise and content. The pilot themes selected exhibit a wealth of Heritage Crafts in tangible and intangible dimensions and are directly related to European history. Two of the consortium partners, CNR and FORTH, will collaborate on the knowledge representation activity. CNR's expertise lies in the representation of knowledge, the implementation of the online platform for semantic annotation and the modelling of the narrative. In particular, its knowledge of the Europeana data model and narrative generation from knowledge models is complementary to that of FORTH regarding CIDOC-CRM.

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WADCHER

Web accessibility directive decision support environment
Co-funded by Horizon 2020

Designing interactive applications for people with disabilities is becoming an increasingly important topic for several reasons. Accessibility has become necessary due to the rapid growth of online information and interactive services provided by web and mobile applications. The recent European Web Accessibility Directive (WAD) promotes the rights of disabled people. In addition, making Web and mobile apps more accessible results in a better user experience for all, not just for users with disabilities.

In order to support accessibility, it becomes important to have tools (validators) able to check, automatically or semi-automatically, the correspondence between the requirements of accessibility guidelines and the characteristics of the Web pages under consideration. These tools are useful for those involved in developing Web sites as, through them, Web designers and developers can easily and quickly check whether their work meets the requirements of the

guidelines, and, in the case of failure, are able to make the appropriate corrections.

In this perspective, the EU WADCHER project aims to build a large-scale accessibility assessment infrastructure, which will be able to develop and demonstrate advanced decision support tools, implement a web accessibility observatory, validate WADcher results in real-world pilots, and develop methods and tools with which organizations can measure and report testing results.

In this project, the HIIS laboratory will integrate and extend the MAUVE validator tool, which is publicly available at https://mauve.isti.cnr.it/. This tool is able to validate guidelines specified through an XML-based language, and externally stored, so that it can be easily updated to support the validation of new guidelines. For example, MAUVE has recently been updated to support the validation of the W3C WCAG 2.1 guidelines. It has the ability to validate various de-

vice-specific versions of a website (Desktop, Tablet, Smartphone, ...), and dynamic website validation through browsers' plugins. MAUVE also provides a Web developers-oriented report system, with indications of the accessibility problems directly in the web page source code.

Validators are fundamental in making the validation process more efficient, consistent, reliable and cost-effective. WADcher will provide an integrated platform, offering accessibility tools and interfaces to support its main stakeholders (web commissioner, web developers, ...).

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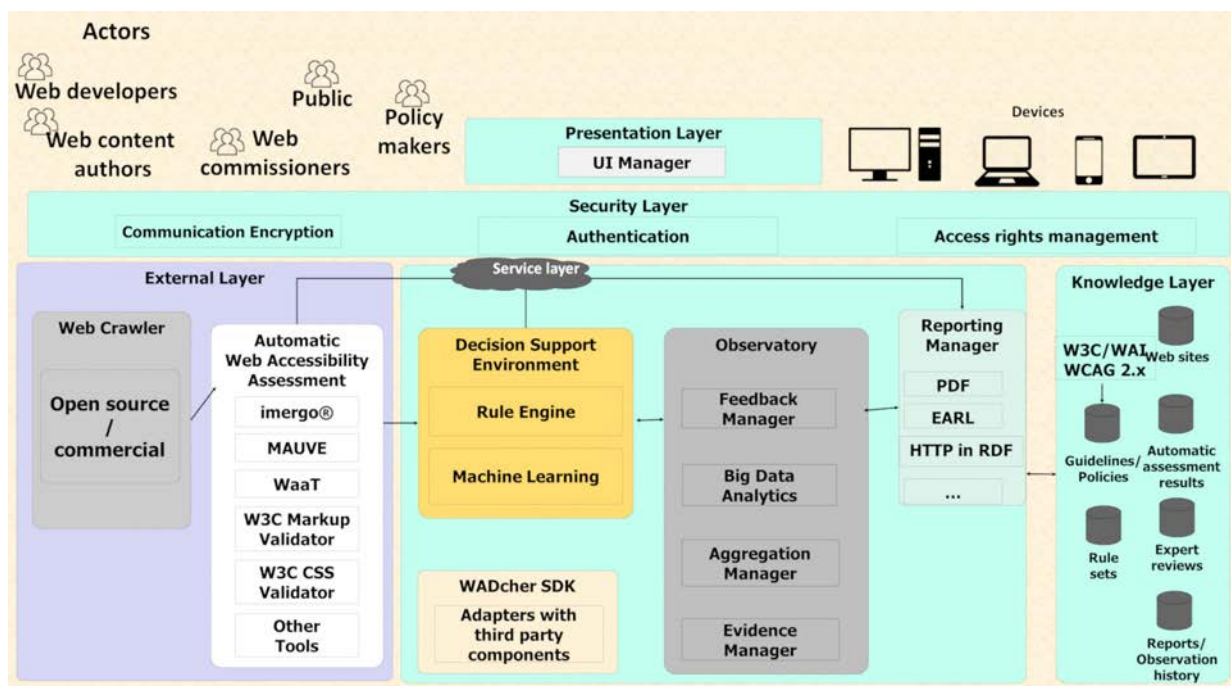
MASTER

Multiple ASpects TrajEctoRy management and analysis
Co-funded by Horizon 2020

MASTER

MASTER, a project coordinated by ISTI, began on March 1st, 2018 and will last 48 months. The objective of MASTER is to form an international and inter-sectoral network of organisations working on a joint research programme to define new methods to build, manage and analyse multiple aspects semantic trajectories.

The Consortium is composed by ten partners, both academic and non-academic istitutions.

The underlying idea is that pure movement data can be enriched with multiple heterogeneous contextual aspects. These aspects are intimately interconnected and the trajectory should be referenced as a whole as holistic trajectories.

The scientific concept of MASTER is driven by research challenges around the definition, management and analysis of holistic trajectories and potential market opportunities in the field of tourism, sea monitoring and public transportation. We propose methods to analyze and infer knowledge from holistic trajectories, considering privacy and Big Data questions as vital issues.

As privacy is a particularly critical issue when analysing trajectory semantically rich data, the MASTER consortium is assisted by the Independent Ethics Advisor Prof. Bettina Berendt and an Ethical Committee (Dr. Rosaria de Luca from CNR, Prof. Tommaso Piazza from UNIVE and Prof. Celia Zolynsky from UVSQ).

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IRIDE

Development of a smart line for tissue conversion: ICT technologies in favour of advanced automation
Co-funded by the Tuscany Region under the POR FESR Toscana 2014-2020 program

Tissue conversion lines represent one of the key plants in the paper industry: tissue paper is transformed into finished products for domestic use and sanitation (absorbent paper, toilet paper, napkins, handkerchiefs, …).

One of the key factors in the competitiveness of tissue conversion lines is productivity and the ability to perform the tissue conversion process in a cost-effective way.

Although the plants on the market are already highly productive, a survey of the state of the art has shown that there are still bottlenecks due to the lack of automation of some aspects.

The IRIDE project aims to eliminate these obstacles and complete the automation of tissue conversion lines by introducing a set of innovations based on the convergence of ICT solutions applied to advanced automation.
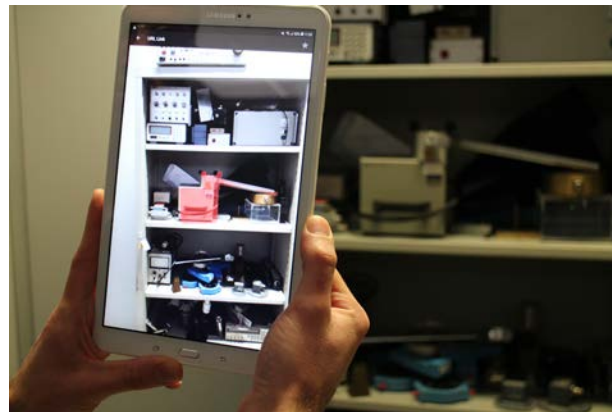
In particular, we intend to use advanced methods of computer vision and video analytics to pervasively monitor the conversion lines and automatically extract process measurements, in order to self-regulate both the parameters of each machine and the global parameters. There will, therefore, be a continuous interaction between the cyber and physical world that will enable advanced automation, with the consequent optimization of efficiency. Big data analysis methodologies will also be in-corporated to derive new knowledge and, on the basis of the data collected, to infer models for the optimal management of the processes, which can be used for predictive maintenance purposes. Augmented reality interfaces will be designed to provide proactive support to the staff during operation and maintenance.

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STINGRAY

SmarT station INtelliGent RAilwaY
Co-funded by the Tuscany Region under the POR FESR Toscana 2014-2020 program

Researchers from the Formal Methods and Tools and the Software Engineering and Dependable Computing groups of ISTI-CNR are working to renew the role of the railway station, traditionally seen as a meeting point for a city, in order to enhance its importance and integration in the Smart City of the future.

Railway stations are a primary point of aggregation in every urban centre, but traditionally they are isolated from the urban context. They have a private energy distribution and communication system, mainly to prevent blackouts and unauthorized intrusions. However, this isolation has two main drawbacks. First, there is no integration with the so-called Smart Cities, where information between different transport systems (i.e. bike sharing, car-sharing, urban transport) is meant to be synergically exploited. Second, the station system is excluded from modern techniques of energy saving.

STINGRAY is focused on the study, design and development of a station communication infrastructure, integrating power line and wireless technologies, which:

i) develops a LAN network over the station plants using power line and wireless technologies;

ii) enables the control and monitoring of station equipment (Supervisory Control And Data Acquisition-SCADA);

iii) creates value added services for both customers and railway staff, such as connectivity, monitoring, Energy Management Service (EMS), Fault Prediction Service (FPS), video surveillance, environmental surveying, infomobility.

STINGRAY represents an opportunity for a more efficient management of machinery and energy resources. It promotes a technological innovation, obtained without building new expensive infrastructures, thanks to the exploitation of power lines, and results in a lower environmental impact.

We are currently defining the requirements for smart stations and the design of the system architecture. We are also working on the optimization of existing strategies for managing energy consumption within a smart station, so as to avoid the waste of energy. Examples of different applications of this technology are the heating of rail road switches and the automation of station lighting.

Stingray will run until July 2020 and is coordinated by Letizia Bellini from ECM spa (Italy).

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Smart Station App

Lo *"Smart Station Ticket"* può includere tutti i servizi della **Smart City**

SMART MOBILITY
Stazioni di ricarica con vetture elettriche pronte da utilizzare in città, aeroporti e servizio prenotazione parcheggi

SMART CONNECTION
Wifi libero in stazione e in luoghi convenzionati Smart Station

SMART ADVERTISING
Totem interattivi, advertising su Smartphone con suggerimenti per itinerari e o info di pubblica utilità

SMART ENJOYMENT
Possibilità di convenzione con centri divertimento, partite di calcio, sport, musei, luoghi di culto
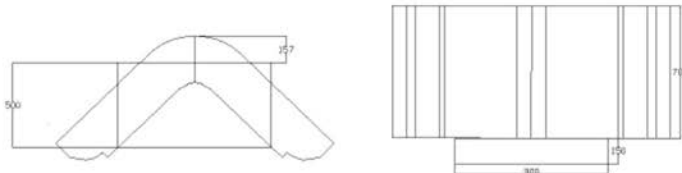
ADA

Automatic Data and Documents Analysis to enhance human-based processes
Co-funded by the Tuscany Region under the POR FESR Toscana 2014-2020 program

language, to simplify and automatize test processes.

The approach proposed by the project is to give a key role to the know-how of a company's employees in compliance with the Industria 4.0 guidelines. Employees, in fact, represent a valuable source of information. People are the most intelligent sensors that a company has and, differently from hardware sensors, they possess the capability of providing data, processed in a complex way but easily understandable. ADA intends not only to focus on making production processes more effective and efficient but also to rethink and redesign these processes from scratch, integrating the users and the human operators in the process. In this way, people will have a key role in the management of the flow of knowledge.

In ADA, ISTI, and more specifically the AI-MIR research group (http://aimir.isti.cnr.it) of the NeMIS lab, has the role of studying and building solutions to analyze images in technical documentation and to make them searchable in an easy and efficient way. Technical documentation can be aggregated and organized according to the visual information contained. Users will be provided with a more intuitive way of accessing documents. It will be possible not only to search text but images will also be retrievable and information can be extracted from them.

The ADA project aims at building a platform based on systems for big data analytics that enable acquisition, management, and automatic retrieval of information from text and images in technical documentation. This should be made possible in the various phases of design, development, testing, deployment, installation, and support of hardware and software products. More specifically, ADA intends to investigate the extraction from technical documentation of "test-cases" written in non-ambiguous

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CompTo-NM

Computed Tomography and Nuclear Medicine
Co-funded by the Tuscany Region under the POR FESR Toscana 2014-2020 program

CompTo-NM is working to design, prototype and validate a hybrid diagnostic platform that integrates nuclear medicine sensors (Positron Emission Tomography - PET or Single Photon Emission Computed Tomography- SPECT) and Cone Beam Computed Tomography (CBCT) technology, into a single, compact, and transportable device that can serve clinical and pre-clinical investigations of brain anatomy and function. The ultimate goal is to create a high-performance device for the study of neurodegenerative and cerebrovascular disorders, whose epidemiological impact is constantly growing, especially in the western world, and is expected to become very significant in the next few years, with an increase in social costs. Although, hybrid technology is already available in clinical practice, it is not yet optimized for the neck and en-

cephalic zones as it consists of full-body devices used in oncology (only 5% of these is dedicated to neuro-vascular diseases). A dedicated device may guarantee lower costs, reduced doses, decongestion of waiting lists and ease of use. CompTo-NM moves in this direction, leveraging the technologies that enable the Industry 4.0 paradigm to support the design and development processes of the hybrid device and implement its predictive maintenance. The ISTI team is working to devise a physical-virtual platform to virtualize the components of the hybrid device and simulate their functioning. The platform will provide feedback on tests on real components, thus supporting design and maintenance activities. The corresponding cyber-physical framework will map the behaviour of the hybrid device in various use cases and validate its adherence to the

theoretical models. By serving the monitoring, diagnosis and prognosis of the state of the device, this framework aims to optimise:
- the development phase, through a controlled, modular and reusable modelling of the production process,
- the performance of the final device, in terms of reliability, maintainability, efficiency and safety, reducing maintenance costs and times and optimizing after-sales services.

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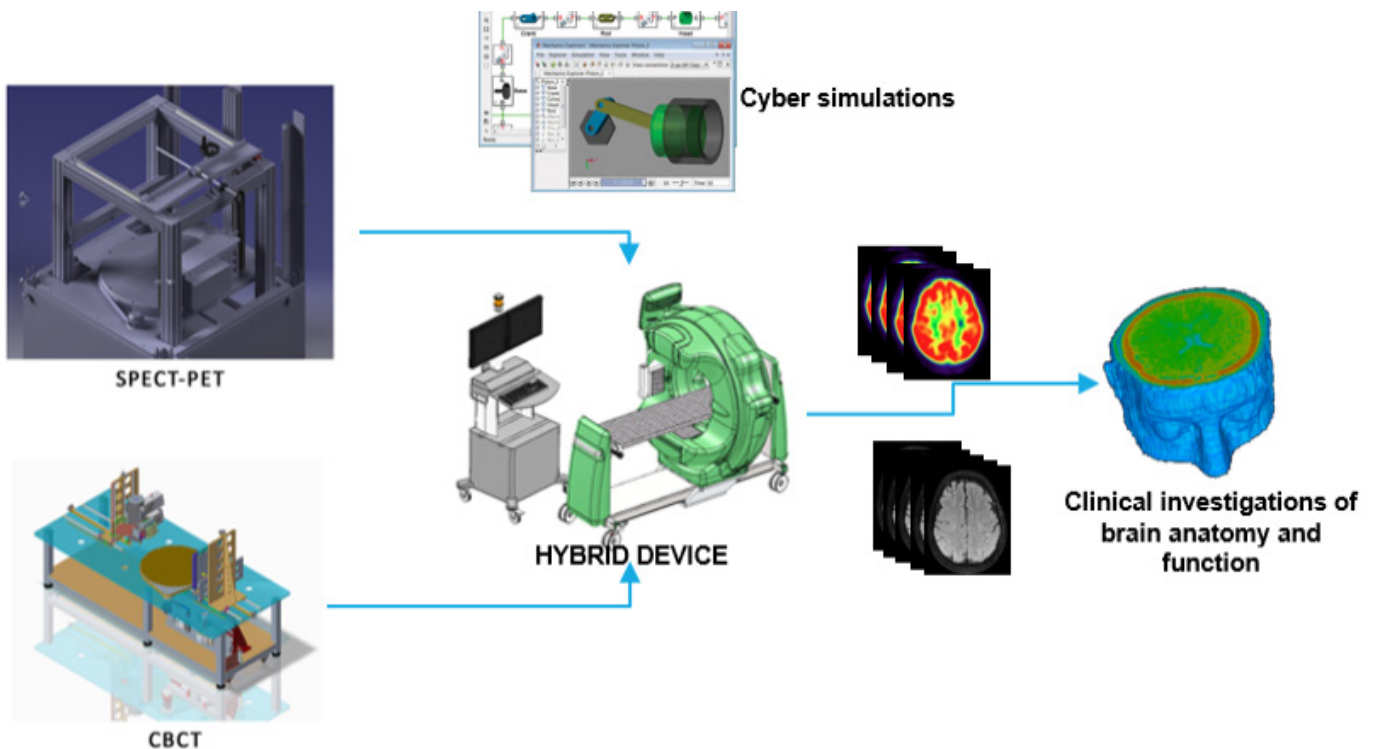
APIC

Personalization environments for Internet of Things applications in the paper sector
Co-funded by the Tuscany Region under the POR FESR Toscana 2014-2020 program

Industry 4.0 is aimed at creating intelligent factories in which operators, equipment, smart devices and advanced automation solutions are expected to cooperate to achieve enhanced flexibility, improved productivity and higher manufacture quality. Following this trend, industrial working environments are becoming increasingly richer in sensors and interconnected IoT-based devices able to detect a variety of dynamic information about the factory. This is expected to allow relevant stakeholders to monitor the current state of the system and properly control its functioning through advanced applications. However, since factory requirements often evolve over time due to e.g. changing market demands and strategies, the factory must be able to quickly respond to new emerging needs in a flexible and timely manner. The APIC Project investigates effective ways to enable workers and managers in the paper sector to customize working environments in a context-dependent manner when specific situations occur inside or outside the factory. These situations can regard people, technologies, or the surrounding environment. In the context of the paper industry, they can be associated with paper quality (e.g. level of humidity, absence of defects, weight), working environment (e.g. presence of toxic gas/smoke in the plant, temperature inside and outside the plant, level of noise), or working conditions (e.g. position, posture of operator). Corresponding reactions include notifications, alarms, warnings and reminders, as well the control of factory equipment (e.g. changing the temperature of driers, activating flashing lights to signal potentially risky situations).

CNR participates in APIC through the HIIS Lab. The project will last 18 months and it is coordinated by Virtualis, a software company based in Lucca.

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http://apic.isti.cnr.it/
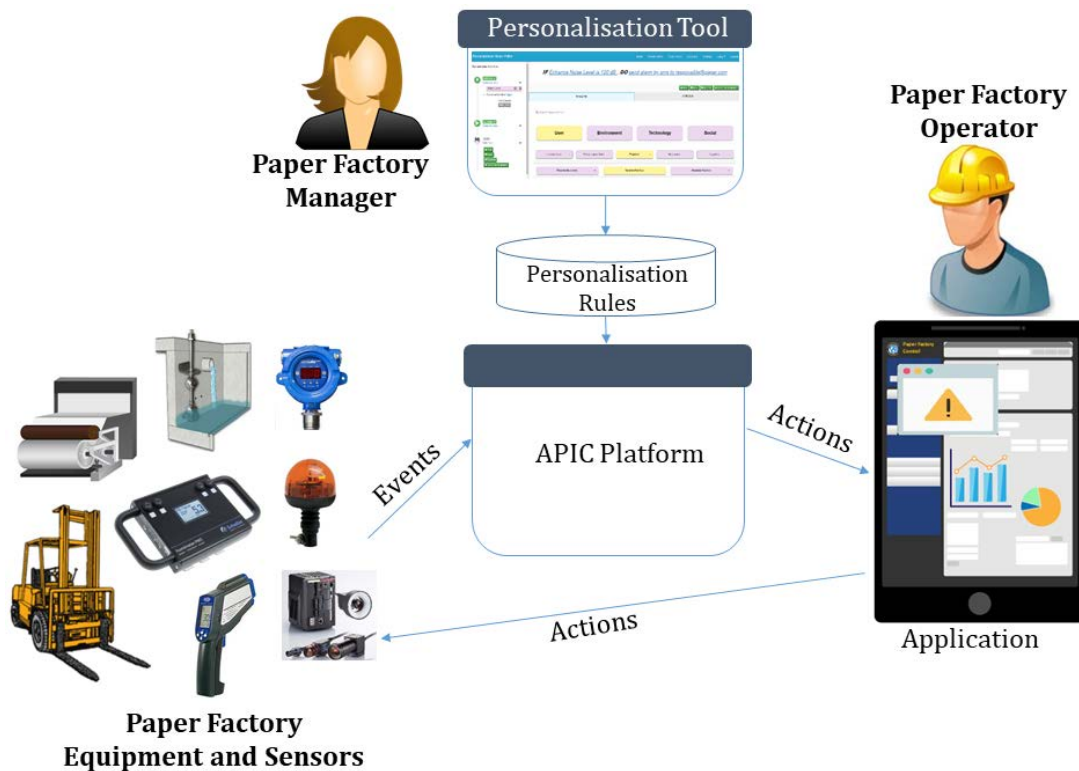
KI-FOOT

A smart shoe for gait analysis
Co-funded by the Tuscany Region under the POR FESR Toscana 2014-2020 program

The Evocation project aims to create a leading European-wide doctoral Collegium for research in advanced visual and geometric technologies that target the emerging fields of 3D Capture and Fabrication.

This doctoral Collegium will train the next generation of creative, entrepreneurial and innovative experts who will be equipped with the necessary skills and competence to face current and future major challenges in scalable and high-fidelity geometry and material acquisition, extraction of structure and semantic information, processing, visualization, 3D display and 3D fabrication in professional and consumer applications. ISTI will participate in the project by working on two main themes: 3D acquisition and digital fabrication.

With respect to innovation in visual and geometric acquisition we aim to enable scalable and cost-effective high-fidelity mass-digitization of the shape and appearance of large collections of 3D objects with complex materials going beyond manual acquisition of single objects to the automated multimodal acquisition of large collections. In fact it is still a challenge to enable fast, scalable, and repeatable capture of large collections and to automatically derive structured and semantically-rich representations.

In addition to fostering innovation in computational fabrication, we envision extending the reproduction capabilities of current 3D printing technologies and processes. The intention is to investigate better computational design approaches able to represent and predict visual and physical properties of real world material in an accurate and reliable manner, leading to improved production pipelines that go from acquisition or design to 3D fabrication in a more predictable and straightforward way. We will also study less explored aspects of the manufacturing pipelines, where human experience and skills are currently necessary for successful fabrication, in order to fully automatize them.
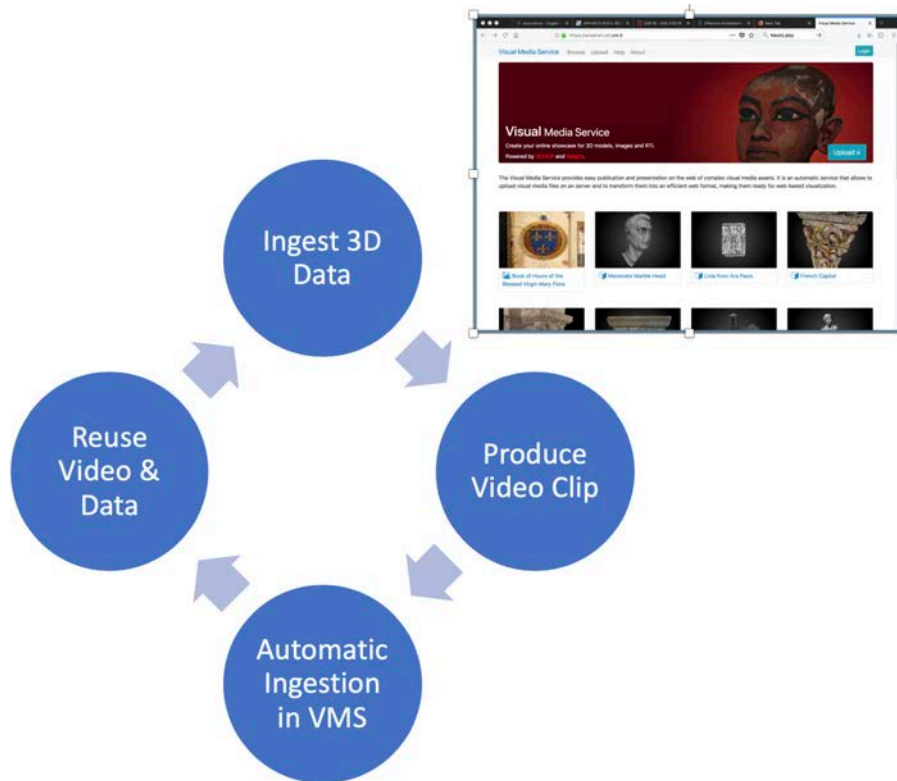
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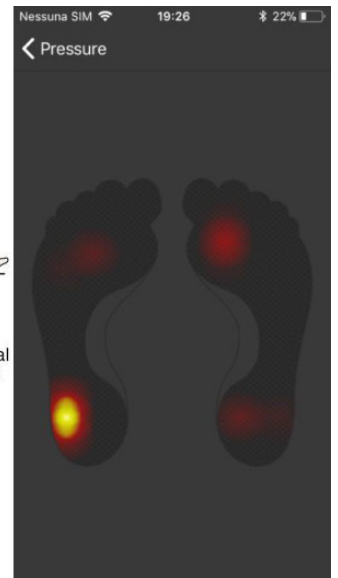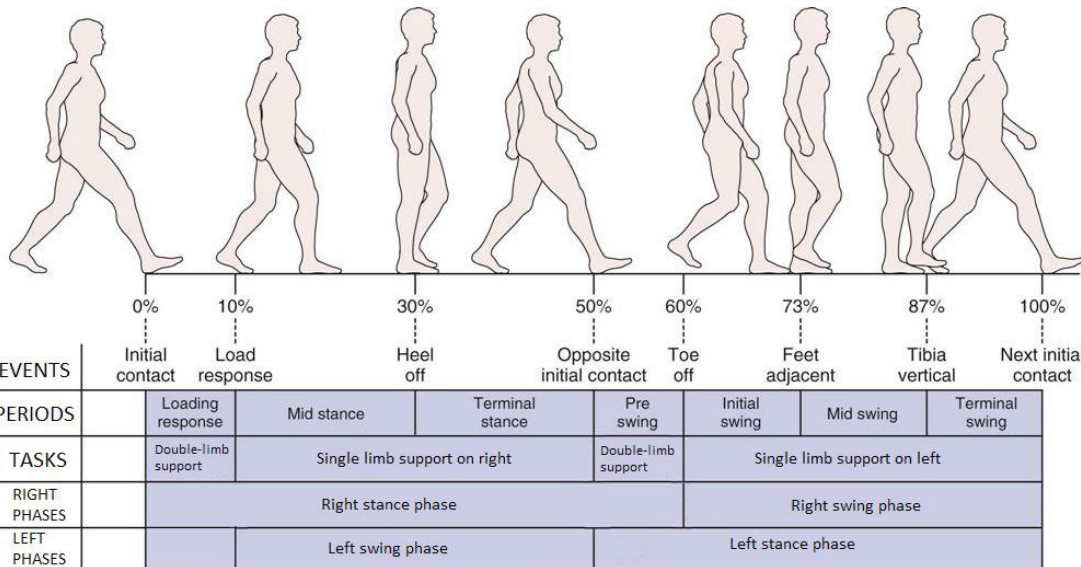
MIUR Cluster "CultMedia"

CultMedia: machine learning-based services for harvesting multimedia documents to support low-cost video post-production and cross-media storytelling".
Funded by the Italian Ministry of Education, University and Research

The Cultural Heritage industry needs new technologies for the inexpensive production of high-quality multimedia digital content, allowing the reuse of existing material in the creation of low-cost media production. The quantity of available multimedia material is unbelievable: the larger cultural sites and institutions possess enormous visual archives, often unexploited; at the same time much of the visual and documentary material produced by experts, scholars and tourists is lost on the internet.

Of the various media available, video is becoming the principal component for knowledge communication and sharing. However, video production is changing, since users now prefer to watch very short video clips. Thus, new paradigms of video production must be followed, identifying and extracting short high-quality clips from the existing visual footage and creating new effective storytelling blocks. The CultMEDIA project aims to facilitate the development of audio-visual and transme-

dia storytelling by optimizing the costs and complexity of cultural media production.

The project will exploit new advances in machine learning for automatic video semantics understanding, for annotation also in natural language, for the recognition of "sentiment" in data, for search and retrieval in order to manage and reuse existing material, including 3D graphics, with the aim of producing high-quality video.

In terms of innovation, the project will provide a disruptive improvement in processes and services related to cultural heritage content production:

a) handling the creation of multimedia video (i.e. containing text, audio, images, clips, 3D animations) and new transmedia storytelling (i.e. exploiting different media platforms, from video to web, to augmented reality, to improve user experience), thanks to the creation of a service platform and open-source software tools;

b) providing large cost savings through the extended use of machine learning and artificial intelligence solutions for the reuse of existing multimedia material and its integration in new productions.

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MutInf_ParComp

Mutual information in weakly-coupled process-algebraic mutual observers
Funded by Silicon Valley Community Foundation

Some of the most attractive as well as arduous questions in contemporary science rotate around the elusive phenomena of consciousness and self-consciousness. Is our ability to have first-person experiences just an emergent property of the complex neuron interconnection pattern of our brain? Can it arise in a piece of hardware of equally complex architecture? Integrated Information Theory (IIT), developed by neuropsychiatrist Giulio Tononi (Univ. of Wisconsin) and others in the last 15 years, offers interesting mathematical tools for addressing these questions. Based on various informational measures, such as Mutual Information ('MutInf') and Kullback-Leibler divergence, IIT culminates in the formal definition of Φ integrated information which measures the amount of con-

sciousness exhibited by a massively parallel natural or artificial system. In essence, once a suitably defined 'optimal' partition of the system is identified, Φ integrated information measures the extent to which the integrated whole is more than the sum of the independent parts.

The MutInf ParComp project originates from the observation that the tools of IIT are perfectly applicable to general, concurrent transition systems and can therefore also be used in Software Engineering to obtain quantitative characterisations of systems of communicating processes. In particular, we focus on the structuring tools of Process Algebra, notably on the parametric parallel composition operator ('ParComp').

In collaboration with members of Tononi's group at Wisconsin Univ., we have developed software and interactive demonstrations, in Mathematica, to illustrate the application of Mutual Information, Φ and associated measures, both to partitioned Boolean Networks and to parallel compositions of processes with variable coupling degrees. Two of these demonstrations are available at the links below.

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http://demonstrations.wolfram.com/MutualInformationBetweenBooleanNetRegions
http://demonstrations.wolfram.com/IntegratedInformationInPartitionedBooleanNets/

ARCO-CNR

Fostering opportunities for human capital development through high-level training in multi-disciplinary areas: the CNR proposal in Tuscany

On 10 February 2017, the Tuscany Region approved (Regional Decree n. 1514) the "Public Call for Joint Higher Education Projects through the activation of Research Grants (year 2017)" under the funding of FSE POR 2014-2020 Axis A Employment. CNR responded to the Call by submitting an Intervention Program called "ARCO-CNR" consisting of 22 Standard Projects for the activation of 26 biennial co-financed research grants.

20 of the 22 Standard Projects submitted have been funded and involve 8 CNR institutes INO, IGG, ICVBC, IFAC, ISTI, IBIMET, ILC, ICCOM, IFC.

ISTI-CNR participates in the Program with 4 projects: PREA, WAMOS, ViDEMo, VISECH.

PREA (Personalizable Remote Elderly Assistance, scientific director Fabio Paternò) aims to extend the possibility of the elderly remaining in their home environment by increasing their autonomy and assisting them in carrying out their daily activities through intelligent and intuitive web applications. These applications provide users with per-sonalized and context-dependent assistance in their homes with the dual objective of improving the quality of life and reducing the cost of health care.

ViDEMo (Visual Deep Engines for Monitoring, scientific director Fabrizio Falchi) takes inspiration from recent advances in machine learning technologies and in particular from representation learning methods based on multiple and hierarchical representations (deep learning). These advances entail the development of new services, unthinkable only a few years ago, in the context of visual analysis. The project aims to study and further advance the state of the art of image content analysis techniques for the automatic extraction of information that allow searching through similarity, visual navigation and the recognition of objects and faces.

VISECH (Visual Engines for Cultural Heritage, scientific director Giuseppe Amato) aims to study and advance the state of the art techniques on image content analysis, for the automatic extraction of information from cultural heritage related visual mate-rial, to allow automatic description, recognition, classification, and searching

WAMOS (Wi-Fi Analytics for Marketing Optimization Strategies, scientific director Francomaria Nardini). The WAMOS project aims at defining and studying solutions that, starting from the "raw" data extracted from the "Volare" Guest Wi-Fi infrastructure (https://cloud4wi.com/introducing-volare-advanced-guest-wi-fi-platform/) of Cloud4Wi, i) enrich this data in order to calculate indicators of presence, location and mobility, ii) segment the user base according to the potential interest dimensions for a Cloud4Wi client and iii) define a tool to optimize marketing campaigns by identifying the most appropriate user groups to contact. The WAMOS project aims to address these phases through the use of machine learning techniques (classification and ranking), data mining (analysis and creation of models), and techniques of semantic enrichment (segmentation and classification of the user base).

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Modeling reliable M2M/IoT traffic over random access satellite links in non-saturated conditions

F.M. Bacco, P. Cassarà, M. Colucci, A. Gotta
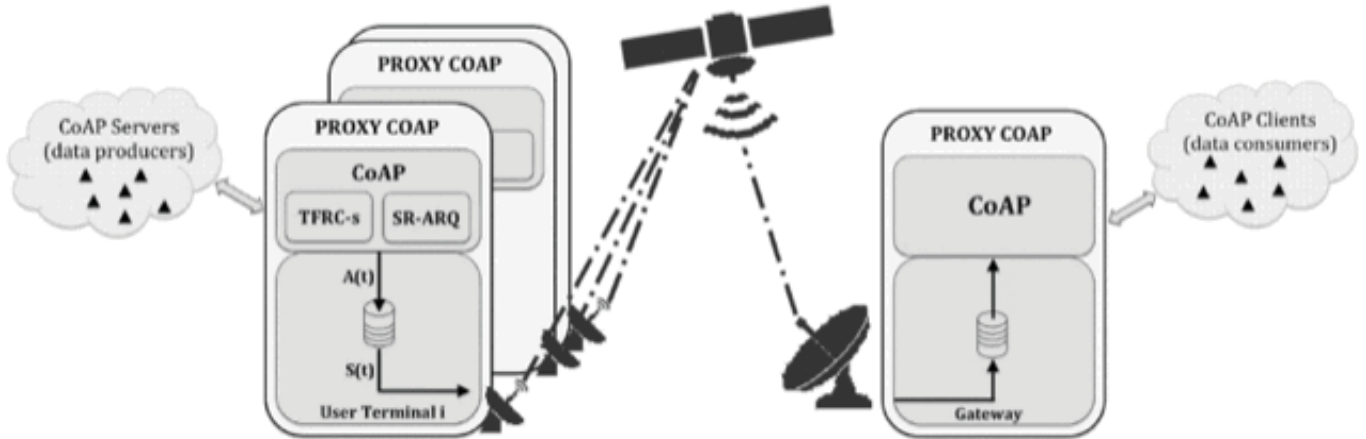
Nowadays, Machine-to-Machine and Internet of Things traffic sources puts the terrestrial networks under great pressure. While 5G is still on its way, satellites are used to deliver a fraction of such an enormous traffic rate. In this work, we investigate the use of the Constrained Application Protocol to reliably deliver Machine-to-Machine and Internet of Things traffic in a push fashion, which also implements a Selective Repeat Automatic Repeat reQuest and a sender-based variant of the TCP Friendly Rate Control protocol. We aim at providing an analytical model to evaluate the working point of the system in non-saturated conditions as a function of the MAC parameters in use, when such a closed-loop congestion control mechanism is in use over a random access satellite channel. The proposed analytical model is then validated against simulation results, showing a good precision
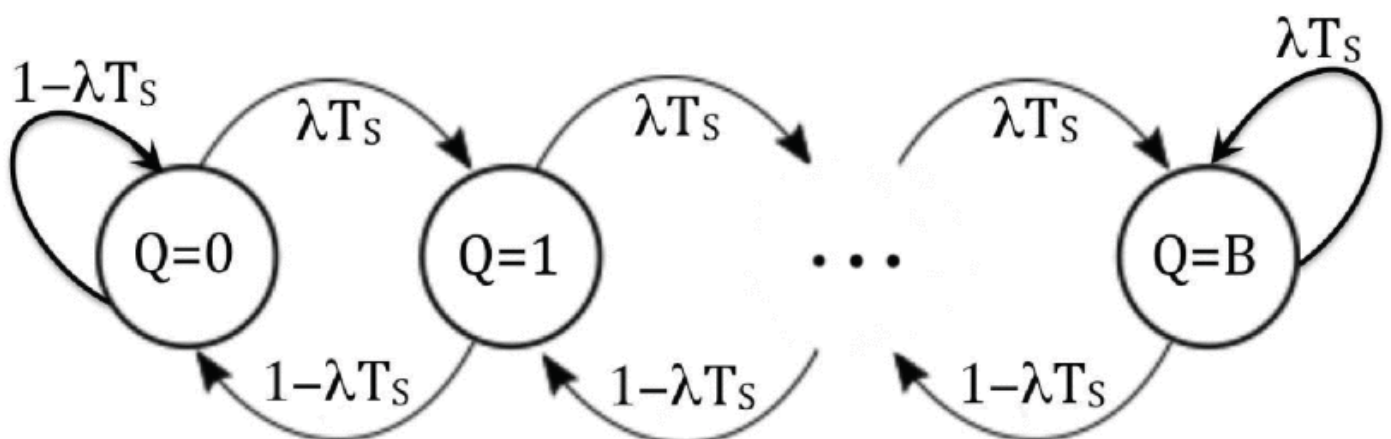
Localising crowds through Wi-Fi probes

F. Potortì, A. Crivello, M. Girolami, P. Barsocchi, E. Traficante
Ad Hoc Networks, vol. 75-76. Elsevier, 2018.1

Most of us carry mobile devices that routinely disseminate radio messages, as is the case with Wi-Fi scanning and Bluetooth beaconing. We investigate whether it is possible to examine these digital crumbs and have them reveal useful insight on the presence of people in indoor locations, as the literature lacks any answers on this topic. Wi-Fi probes are generated sparsely and often anonymised, which hinders the possibility of using them for targeted localisation or tracking. However, by experimenting in three different indoor environments, we demonstrate for the first time that it is possible to extract from them some positioning information. Possible applications include identifying frequented regions where many people are gathered together. In the described experimentation with sniffing devices we adopted finger-printing interpolation, which requires no survey phase and automatically adapts to changes in the environment. The same process can be carried out using the Wi-Fi access points already installed in the environment, thus allowing for operation free of installation, surveying and maintenance.

Scenario CNR — 35m × 15m

Scenario C4WIT — 25m × 15m

Scenario C4WUS — 24m × 20m

Create ensemble
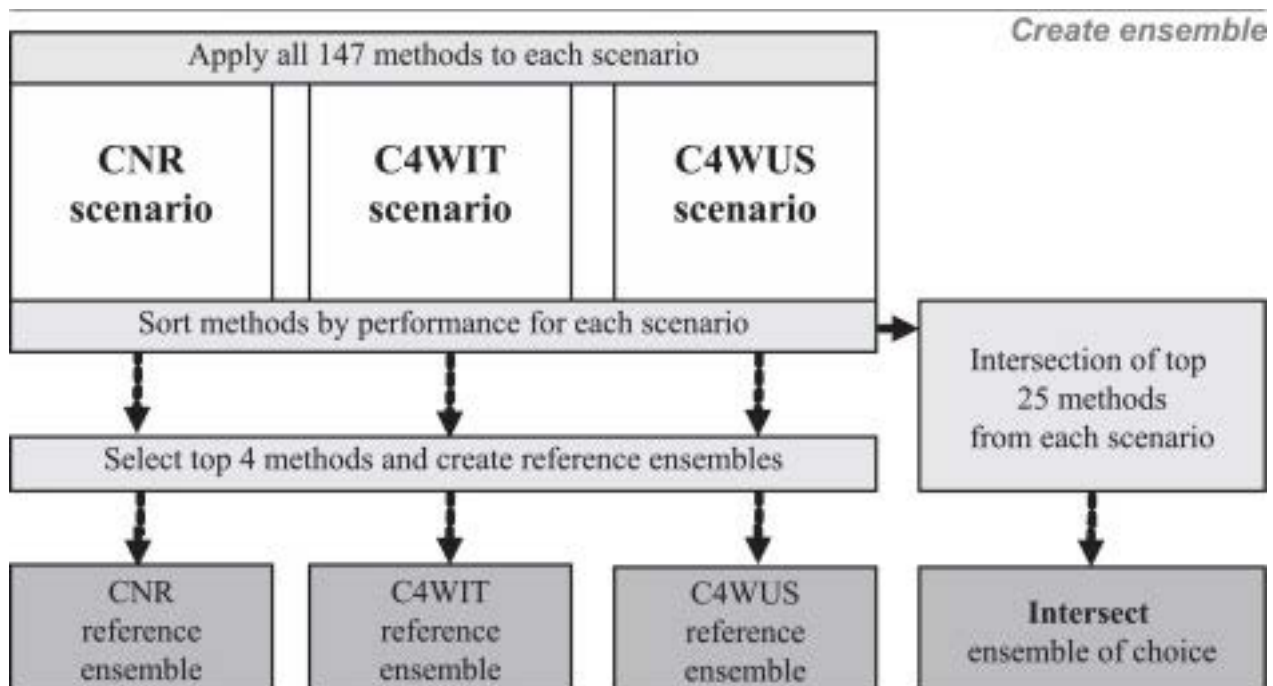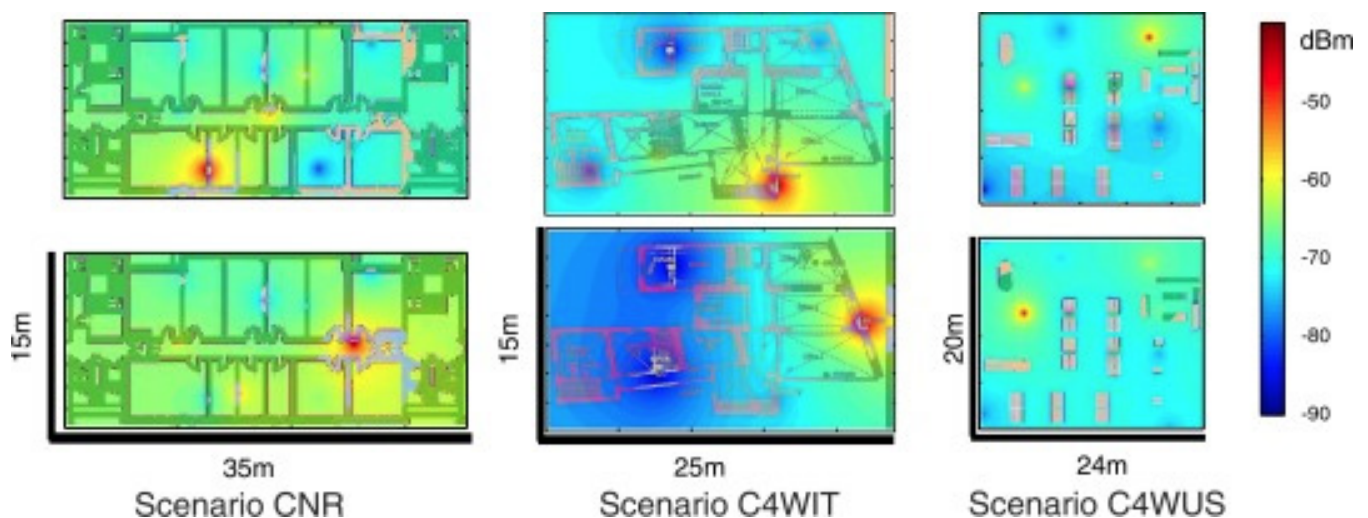
A framework for quantitative modeling and analysis of highly (re)configurable systems

M.H. ter Beek, A. Legay, A. Lluch Lafuente, A. Vandin
IEEE Transactions on Software Engineering. IEEE, 2018.

This paper presents our approach to the quantitative modeling and analysis of highly (re)configurable systems, such as software product lines. Different combinations of the optional features of such a system give rise to combinatorially many individual system variants. We use a formal modeling language that allows us to model systems with probabilistic behavior, possibly subject to quantitative feature constraints, and able to dynamically install, remove or replace features. More precisely, our models are defined in the probabilistic feature-oriented language QFLan, a rich domain specific language (DSL) for systems with variability defined in terms of features. QFLan specifications are automatically encoded in terms of a process algebra whose operational behavior interacts with a store of constraints, and hence allows to separate system configuration from system behavior. The resulting probabilistic configurations and behavior converge seamlessly in a semantics based on discrete-time Markov chains, thus enabling quantitative analysis. Our analysis is based on statistical model checking techniques, which allow us to scale to larger models with respect to precise probabilistic analysis techniques. The analyses we can conduct range from the likelihood of specific behavior to the expected average cost, in terms of feature attributes, of specific system variants. Our approach is supported by a novel Eclipse-based tool which includes state-of-the-art DSL utilities for QFLan based on the Xtext framework as well as analysis plug-ins to seamlessly run statistical model checking analyses. We provide a number of case studies that have driven and validated the development of our framework.
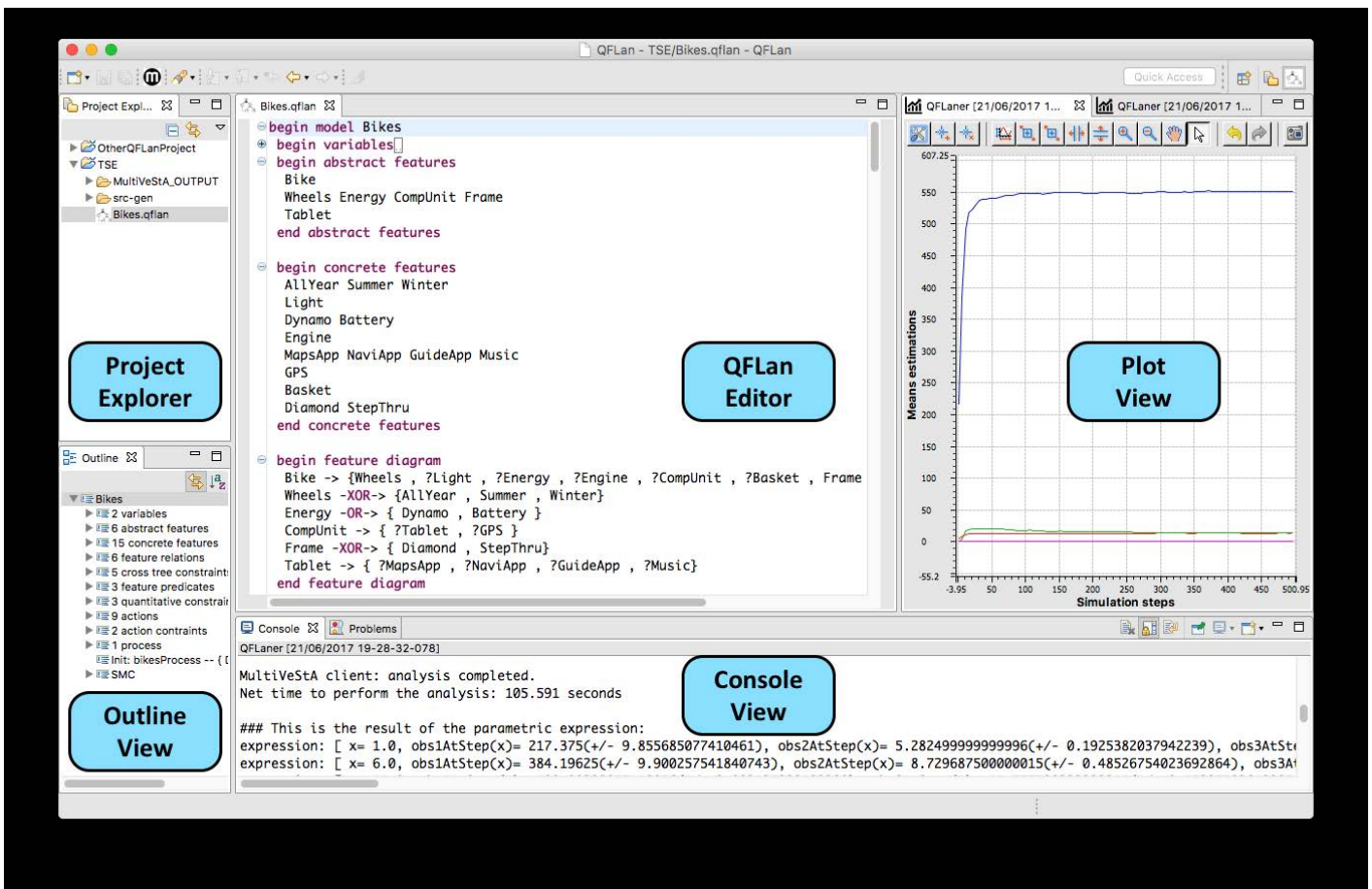
# A guidelines framework for understandable BPMN models

F. Corradini, A. Ferrari, F. Fornari, S. Gnesi, A. Polini, B. Re B., Spagnolo G. O.
Data & Knowledge Engineering, vol. 113. Elsevier, 2018.

Business process modeling allows abstracting and reasoning on how work is structured within complex organizations. Business process models represent blueprints that can serve different purposes for a variety of stakeholders. For example, business analysts can use these models to better understand how the organization works; employees playing a role in the process can use them to learn the tasks that they are supposed to perform; software analysts/developers can refer to the models to understand the system-as-is before designing the system-to-be. Given the variety of stakeholders that need to interpret these models, and considering the pivotal function that m o d -

els play within organizations, understandability becomes a fundamental quality that need to be taken into particular account by modelers. In this paper we provide a set of fifty guidelines that can help modelers to improve the understandability of their models. The work focuses on the Business Process Modelling Notation 2.0 standard published by the Object Management Group, which has acquired a clear predominance among the modeling notations for business processes. Guidelines were derived by means of a thoughtful literature review - which allowed identifying around one hundred guidelines - and through successive activities of synthesis and homog-

enization. In addition, we implemented a freely available open source tool, named BEBoP (understandaBility vErifier for Business Process models), to check the adherence of a model to the guidelines. Finally, guidelines violation has been checked with BEBoP on a dataset of 11,294 models available in a publicly accessible repository. Our tests show that, although the majority of the guidelines are respected by the models, some guidelines, which are recognized as fundamental by the literature, are frequently violated.
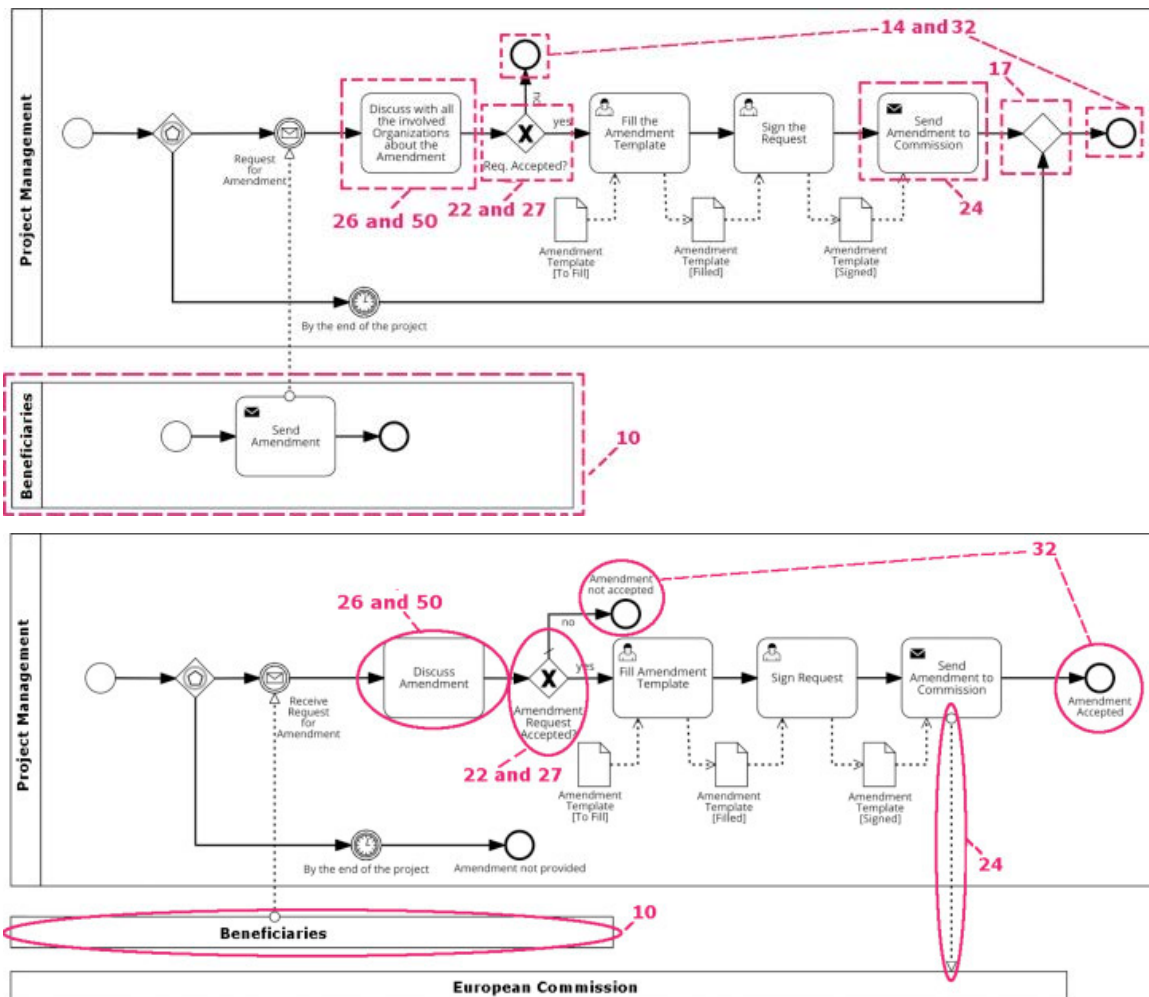
FAST approaches to scalable similarity-based test case prioritization

B. Miranda, E. Cruciani, R. Verdecchia, A. Bertolino,
ICSE 2018 - 40th ACM/IEEE International Conference on Software Engineering. IEEE, 2018.

Test case prioritization (TCP) is applied in software regression testing for speeding up fault detection: a test suite is re-ordered so that those test cases that are the most likely to fail are executed first. Many TCP approaches have been proposed, among which similarity-based ones give priority to those test cases that are the most dissimilar from those already selected. However, existing criteria do not scale up to handle the many thousands or even some millions test suite sizes of modern industrial systems and simple heuristics are used instead. We intro-duce the FAST family of test case prioritization techniques that radically changes this landscape: the simple yet powerful idea behind FAST is that of managing the big "testsets" of modern software development processes through the use of well-established techniques used in the big data domain to find similar items.

FAST techniques provide scalable similarity-based test case prioritization in both white-box and black-box fashion. The results from experimentation on real world C and Java subjects show that the fastest members of the family outperform other black-box approaches in efficiency with no significant impact on effectiveness, and also white-box approaches, including greedy ones, if preparation time is not counted. A simulation study of scalability shows that one FAST technique can prioritize a million test cases in less than 20 minutes. .
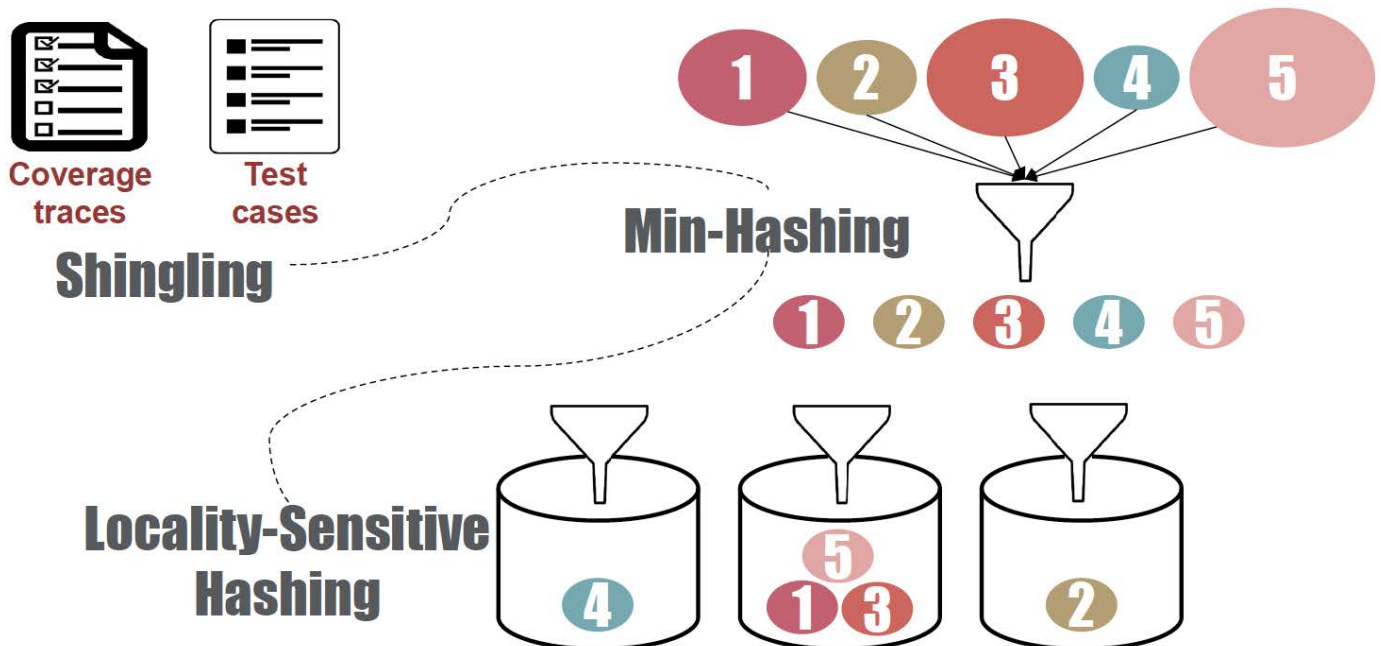
Boosting a low-cost smart home environment with usage and access control rules

P. Barsocchi, A. Calabrò, E. Ferro, C. Gennaro , E. Marchetti, C. Vairo
Sensors, vol. 18. MDPI, 2018.

Smart Home has gained widespread attention due to its flexible integration into everyday life. Pervasive sensing technologies are used to recognize and track the activities that people perform during the day, and to allow communication and cooperation of physical objects. Usually, the available infrastructures and applications leveraging these smart environments have a critical impact on the overall cost of the Smart Home construction, require to be preferably installed during the home construction and are still not user-centric. In this paper, we propose a low cost, easy to install, user-friendly, dynamic and flexible infrastructure able to perform runtime resources management by decoupling the different levels of control rules. The basic idea relies on the usage of off-the-shelf sensors and technologies to guarantee the regular exchange of critical information, without the necessity from the user to develop accurate models for managing resources or regulating their access/usage. This allows us to simplify the continuous updating and improvement, to reduce the maintenance effort and to improve residents' living and security. A first validation of the proposed infrastructure on a case study is also presented.
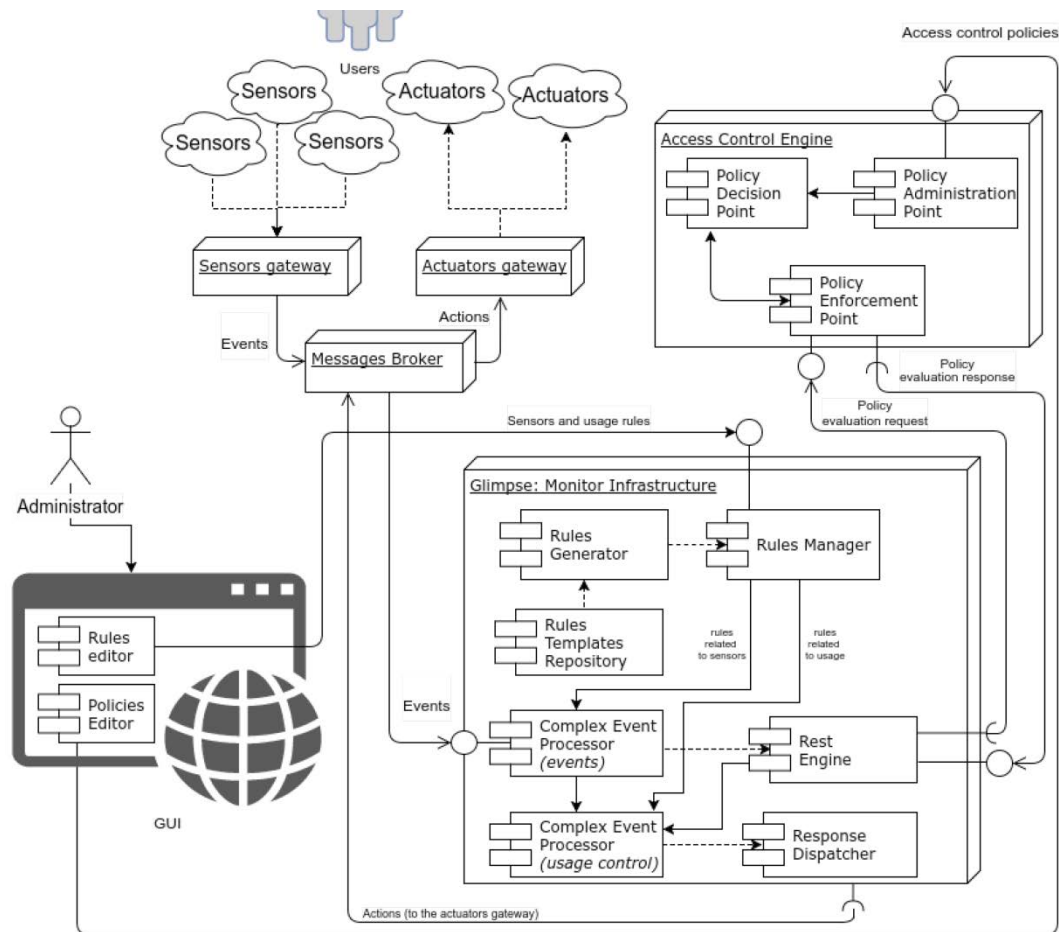
A categorization scheme for software engineering conference papers and its application

A.Bertolino, A. Calabrò, F. Lonetti, E. Marchetti, B. Miranda.
The Journal of Systems and Software, vol. 137. Elsevier, 2018.
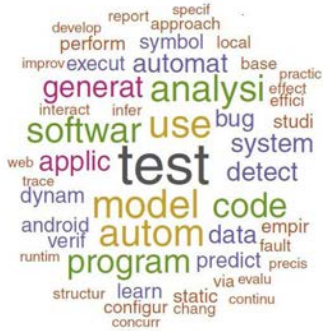
ASE   FSE   ICSE

In Software Engineering (SE), conference publications have high importance both in effective communication and in academic careers. Researchers actively discuss how a paper should be organized to be accepted in mainstream conferences. This work tackles the problem of generalizing and characterizing the type of papers accepted at SE conferences.

The paper offers a new perspective in the analysis of SE literature: a categorization scheme for SE papers is obtained by merging, extending and revising related proposals from a few existing studies. The categorization scheme is used to classify the papers accepted at three top-tier SE conferences during five years (2012–2016).

While a broader experience is certainly needed for validation and fine-tuning, preliminary outcomes can be observed relative to what problems and topics are addressed, what types of contributions are presented and how they are validated.

The results provide insights to paper writers, paper reviewers and conference organizers in focusing their future efforts, without any intent to provide judgments or authoritative guidelines.

(a) ASE   (b) FSE   (c) ICSE
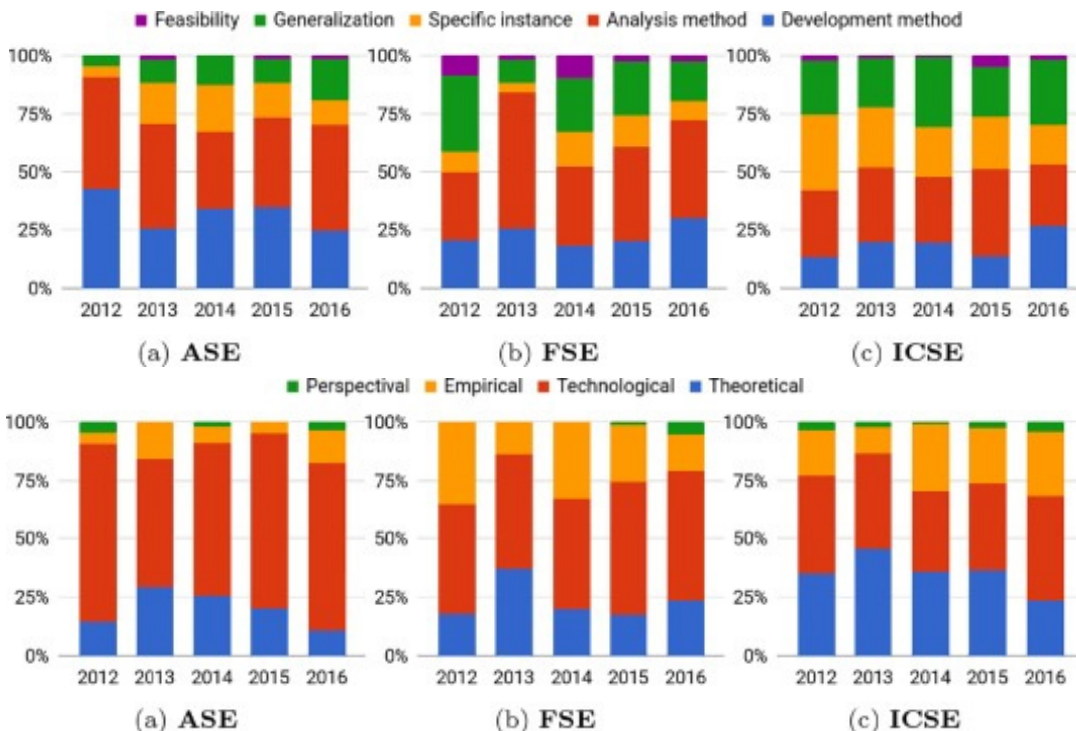
Real-time anomaly detection in elderly behavior with the support of task models

P. Parvin, S. Chessa, M. Manca, F. Paternò
EICS 2018 - ACM on Human-Computer Interaction. ACM, 2018.

With today's technology, elderly can be supported in living independently in their own homes for a prolonged period of time. Monitoring and analyzing their behavior in order to find possible unusual situation helps to provide the elderly with health warnings at the proper time. Current studies are focusing on the elderly daily activity and the detection of anomalous behaviors aiming to provide the older people with remote support. To this aim, we propose a real-time solution which models the user daily routine using a task model specification and detects relevant contextual events occurred in their life through a context manager. In addition, by a systematic validation through a system that automatically generates wrong sequences of tasks, we show that our algorithm is able to find behavioral deviations from the expected behavior at different times by considering the extended classification of the possible deviations with good accuracy.
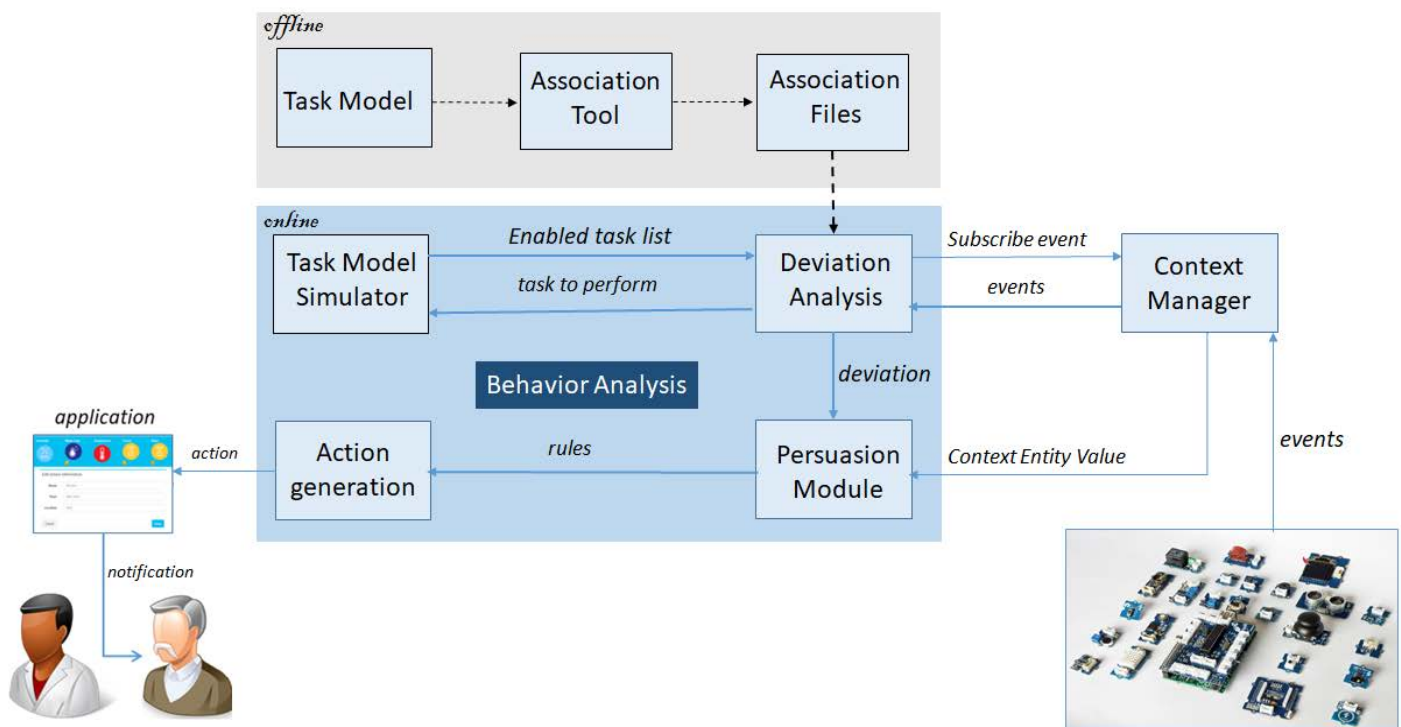
The design of web games for helping young high-functioning autistics in learning how to manage money

S. Caria, F. Paternò, C. Santoro, V. Semucci
Mobile Networks and Applications, vol. 23. Elsevier, 2018.

We describe the design of a Web-based game application aimed to support high-functioning individuals affected by Autism Spectrum Disorder in gaining skills that can help them understand the concept of money and apply it in practical life situations. In order to evaluate the effectiveness and usability of the games, a user study involving six high-functioning ASD individuals in their teens and above was carried out. Preliminary results were encouraging and showed the potential advantages of such a system for training end users on practical life skills. We report on the redesign of the application that has been performed taking into account also the feedback gathered in the empirical validation. During the redesign we also added a more realistic game involving interaction with a vending machine, a tool that is commonly used by teenagers to buy snacks or drinks.

A survey of methods for explaining black box models

R. Guidotti, A. Monreale, S. Ruggieri, F. Turini, F. Giannotti, D. Pedreschi
ACM Computing Surveys, vol. 51. ACM, 2018.

In recent years, many accurate decision support systems have been constructed as black boxes, that is as systems that hide their internal logic to the user. This lack of explanation constitutes both a practical and an ethical issue. The literature reports many approaches aimed at overcoming this crucial weakness, sometimes at the cost of sacrificing accuracy for interpretability. The applications in which black box decision systems can be used are various, and each approach is typically developed to provide a solution for a specific problem and, as a consequence, it explicitly or implicitly delineates its own definition of interpretability and explanation. The aim of this article is to provide a classification of the main problems addressed in the literature with respect to the notion of explanation and the type of black box system. Given a problem definition, a black box type, and a desired explanation, this survey should help the researcher to find the proposals more useful for his own work. The proposed classification of approaches to open black box models should also be useful for putting the many research open questions in perspective.
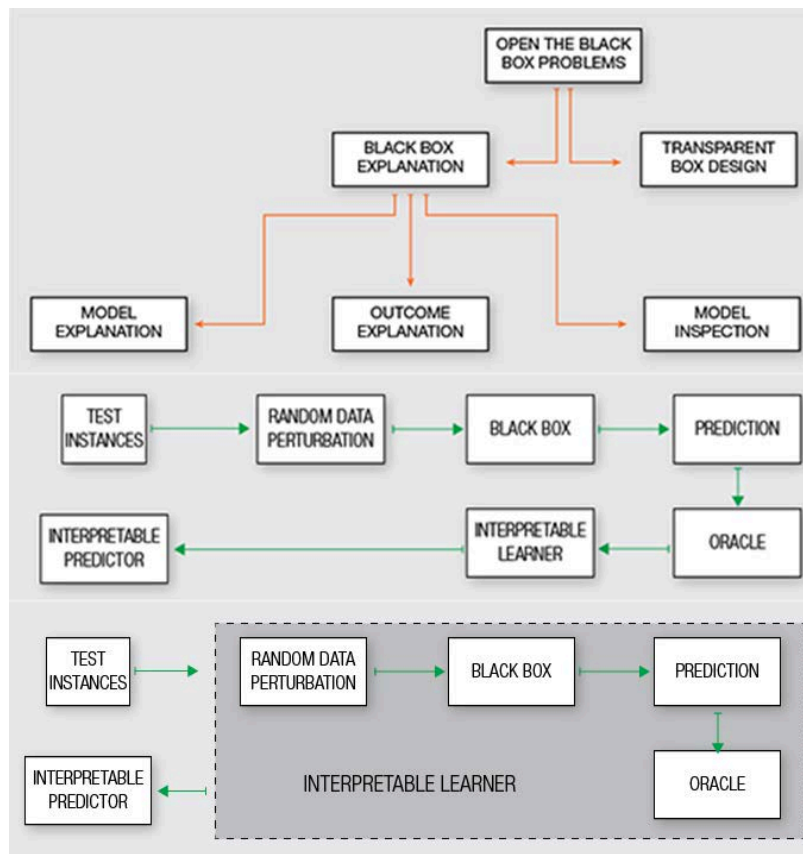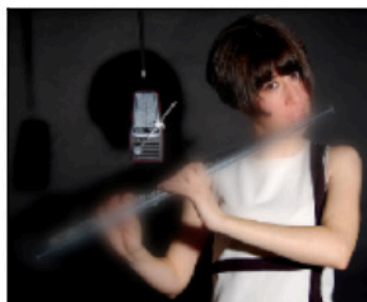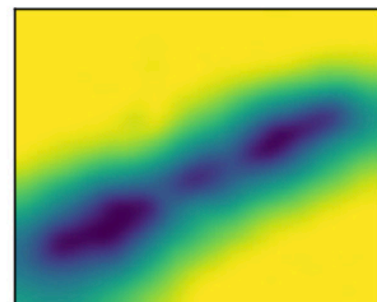
Effective injury forecasting in soccer with GPS training data and machine learning

A. Rossi, L. Pappalardo, P. Cintia, F.M. Iaia, J. Fernandez, D. Medina
PloS One, vol. 13. Public Library of Science, 2018.

Injuries have a great impact on professional soccer, due to their large influence on team performance and the considerable costs of rehabilitation for players. Existing studies in the literature provide just a preliminary understanding of which factors mostly affect injury risk, while an evaluation of the potential of statistical models in forecasting injuries is still missing. In this paper, we propose a multi-dimensional approach to injury forecasting in professional soccer that is based on GPS measurements and machine learning. By using GPS tracking technology, we collect data describing the training workload of players in a professional soccer club during a season. We then construct an injury forecaster and show that it is both accurate and interpretable by providing a set of case studies of interest to soccer practitioners. Our approach opens a novel perspective on injury prevention, providing a set of simple and practical rules for evaluating and interpreting the complex relations between injury risk and training performance in professional soccer.
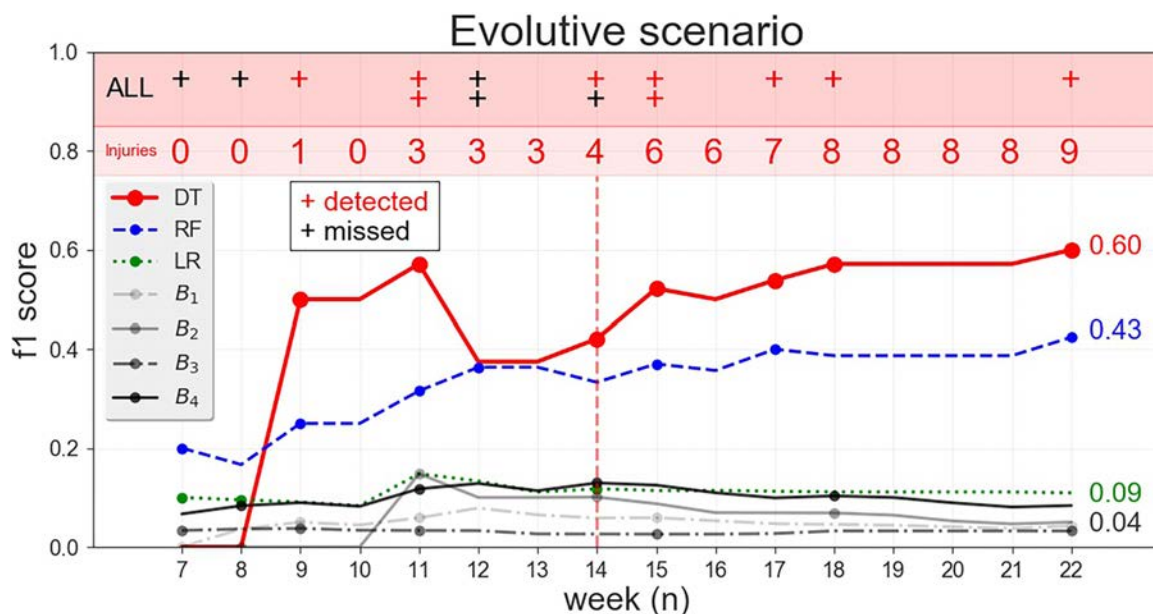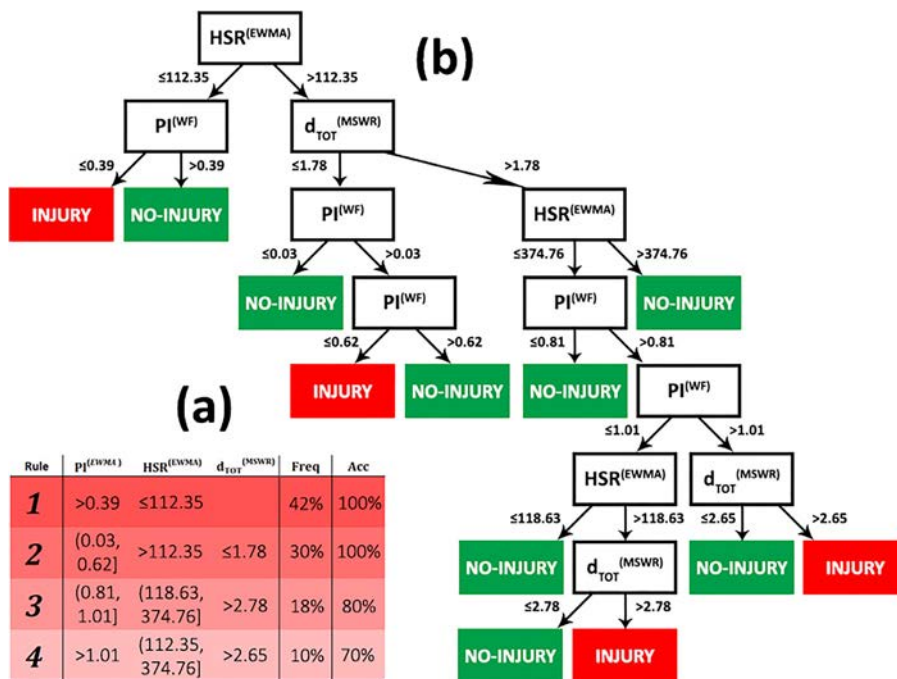
Detecting patterns of climate change in long-term forecasts of marine environmental parameters

G. Coro, P. Pagano, A. Ellenbroek
International Journal of Digital Earth. Taylor & Francis, 2018.

Forecasting environmental parameters in the distant future requires complex modelling and large computational resources. Due to the sensitivity and complexity of forecast models, long-term parameter forecasts (e.g. up to 2100) are uncommon and only produced by a few organisations, in heterogeneous formats and based on different assumptions of greenhouse gases emissions. However, data mining techniques can be used to coerce the data to a uniform time and spatial representation, which facilitates their use in many applications. In this paper, streams of big data coming from AquaMaps and NASA collections of 126 long-term forecasts of nine types of environmental parameters are processed through a cloud computing platform in order to (i) standardise and harmonise the data representations, (ii) produce intermediate scenarios and new informative parameters, and (iii) align all sets on a common time and spatial resolution. Time series cross-correlation applied to these aligned datasets reveals patterns of climate change and similarities between parameter trends in 10 marine areas. Our results highlight that (i) the Mediterranean Sea may have a standalone 'response' to climate change with respect to other areas, (ii) the Poles are most representative of global forecasted change, and (iii) the trends are generally alarming for most oceans.
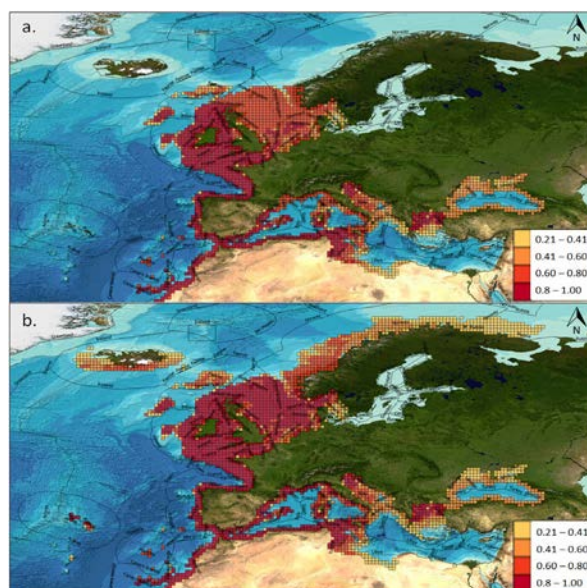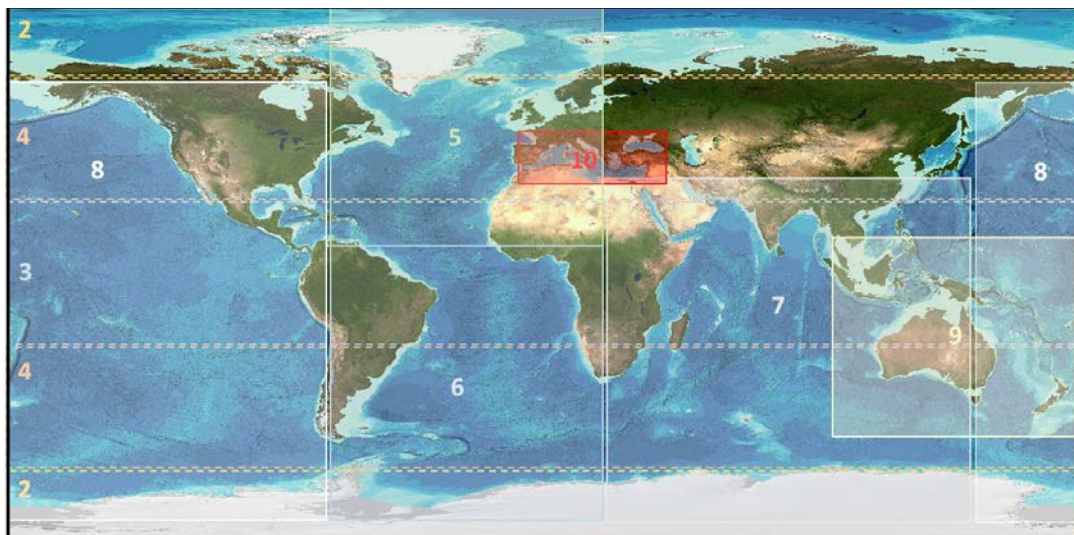
The gCube system: delivering virtual research environments as-a-Service

M. Assante, L. Candela, D. Castelli, R. Cirillo, G. Coro, L. Frosini, L. Lelii, F. Mangiacrapa, V. Marioli, P. Pagano, G. Panichi, C. Perciante, F. Sinibaldi
Future Generation Computer Systems. Elsevier, 2018.

Important changes have characterised research and knowledge production in recent decades. These changes are associated with developments in information technologies and infrastructures. The processes characterising research and knowledge production are changing through the digitalization of science, the virtualisation of research communities and networks, the offering of underlying systems and services by infrastructures.

This paper gives an overview of gCube, a software system promoting elastic and seamless access to research assets (data, services, computing) across the boundaries of institutions, disciplines and providers to favour collaboration-oriented research tasks. gCube's technology is primarily conceived to enable Hybrid Data Infrastructures facilitating the dynamic definition and operation of Virtual Research Environments.

To this end, it offers a comprehensive set of data management commodities on various types of data and a rich array of "mediators" to interface well-established Infrastructures and Information Systems from various domains. Its effectiveness has been proved by operating the D4Science.org infrastructure and serving concrete, multidisciplinary, challenging, and large scale scenarios.
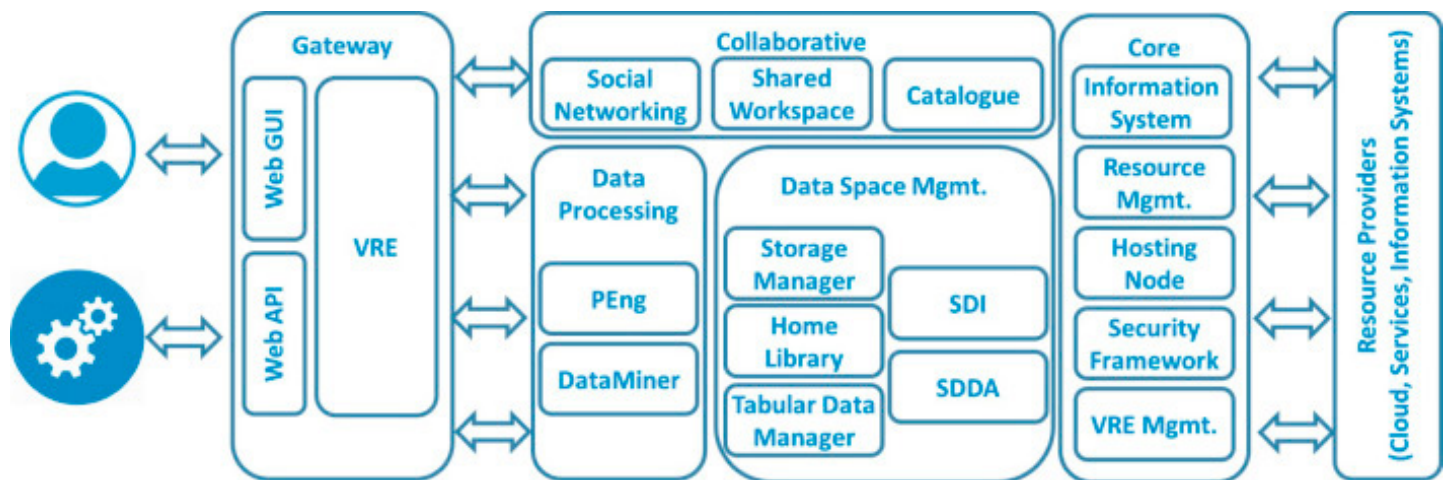
Efficient query processing for scalable web search

N. Tonellotto, C. Macdonald, I. Ounis
Foundations and Trends in Information Retrieval, vol.12. Now Publishers, 2018.

Search engines are exceptionally important tools for accessing information in today's world. In satisfying the information needs of millions of users, the effectiveness (the quality of the search results) and the efficiency (the speed at which the results are returned to the users) of a search engine are two goals that form a natural trade-off, as techniques that improve the effectiveness of the search engine can also make it less efficient. Meanwhile, search engines continue to rapidly evolve, with larger indexes, more complex retrieval strategies and growing query volumes. Hence, there is a need for the development of efficient query processing infrastructures that make appropriate sacrifices in effectiveness in order to make gains in efficiency. This survey comprehensively reviews the foundations of search engines, from index layouts to

basic term-at-a-time (TAAT) and document-at-a-time (DAAT) query processing strategies, while also providing the latest trends in the literature in efficient query processing, including the coherent and systematic reviews of techniques such as dynamic pruning and impact-sorted posting lists as well as their variants and optimisations. Our explanations of query processing strategies, for instance the WAND and BMW dynamic pruning algorithms, are presented with illustrative figures showing how the processing state changes as the algorithms progress. Moreover, acknowledging the recent trends in applying a cascading infrastructure within search systems, this survey describes techniques for efficiently integrating effective learned models, such as those obtained from learning-to-rank techniques. The sur-

vey also covers the selective application of query processing techniques, often achieved by predicting the response times of the search engine (known as query efficiency prediction), and making per-query tradeoffs between efficiency and effectiveness to ensure that the required retrieval speed targets can be met. Finally, the survey concludes with a summary of open directions in efficient search infrastructures, namely the use of signatures, real-time, energy-efficient and modern hardware and software architectures.
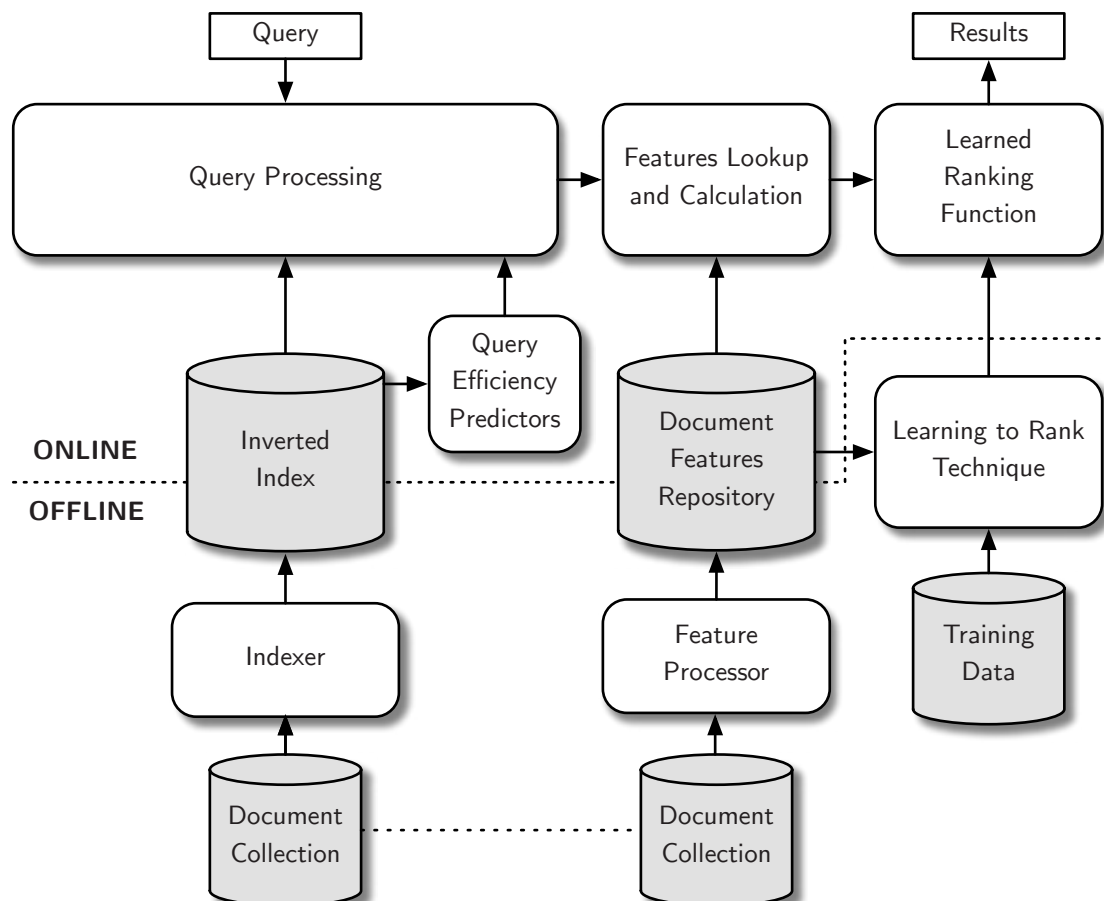
X-CLEaVER: learning ranking ensembles by growing and pruning trees

C. Lucchese, F.M. Nardini, S. Orlando, R. Perego, F. Silvestri, S. Trani
ACM Transactions on Intelligent Systems and Technology, vol. 9. ACM, 2018.

Learning-to-Rank (LtR) solutions are commonly used in large-scale information retrieval systems such as Web search engines, which have to return highly relevant documents in response to user query within fractions of seconds. The most effective LtR algorithms adopt a gradient boosting approach to build additive ensembles of weighted regression trees. Since the required ranking effectiveness is achieved with very large ensembles, the impact on response time and query throughput of these solutions is not negligible. In this ar-
ticle, we propose X-CLEaVER, an iterative meta-algorithm able to build more efficient and effective ranking ensembles. X-CLEaVER interleaves the iterations of a given gradient boosting learning algorithm with pruning and re-weighting phases. First, redundant trees are removed from the given ensemble, then the weights of the remaining trees are fine-tuned by optimizing the desired ranking quality metric. We propose and analyze several pruning strategies and we assess their benefits showing that interleaving pruning and re-weighting
phases during learning is more effective than applying a single post-learning optimization step. Experiments conducted using two publicly available LtR datasets show that X-CLEaVER can be successfully exploited on top of several LtR algorithms as it is effective in optimizing the effectiveness of the learnt ensembles, thus obtaining more compact forests that hence are much more efficient at scoring time.
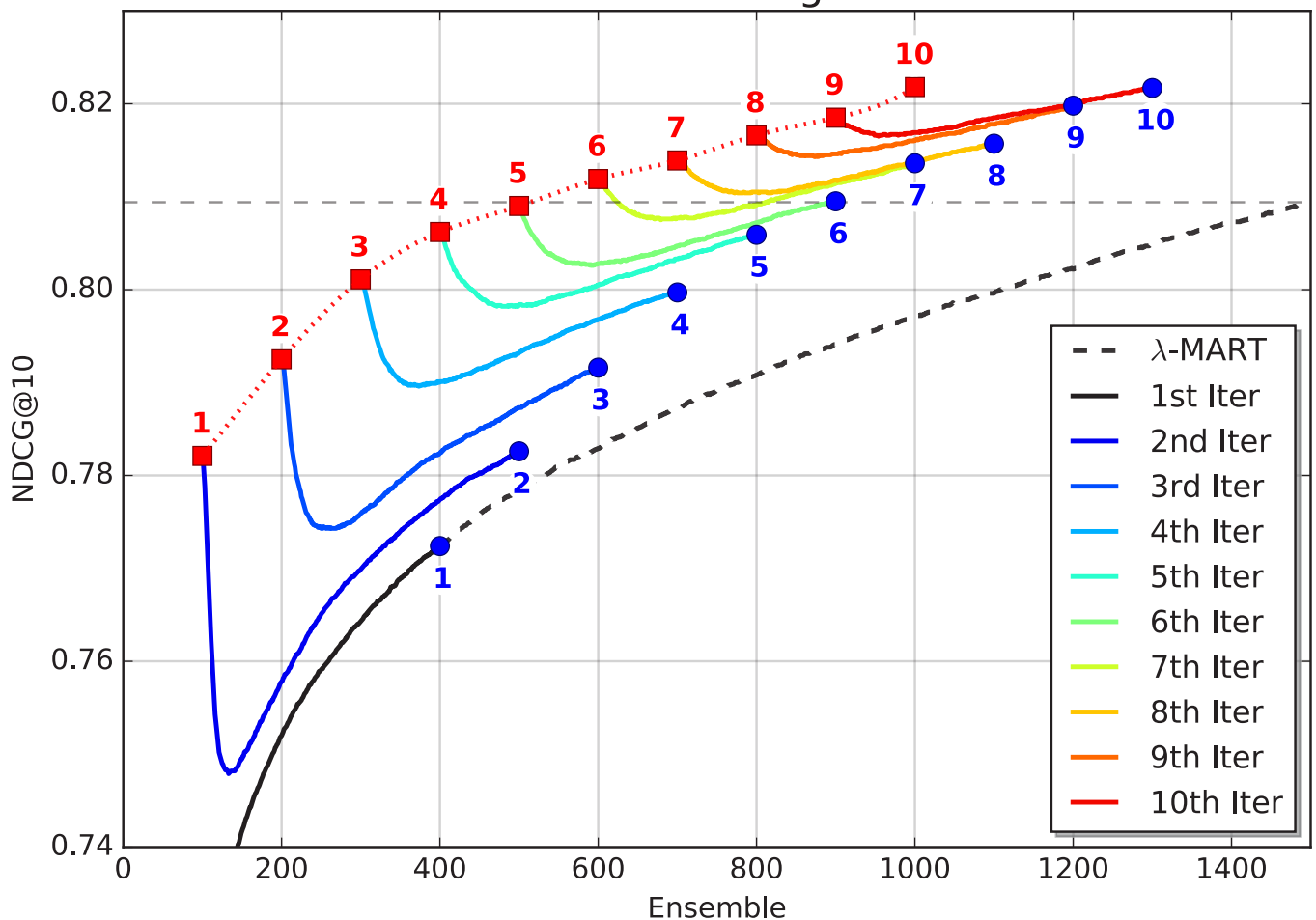
Langevin equation in complex media and anomalous diffusion

S. Vitali, V. Sposini, O. Sliusarenko, P. Paradisi, G. Castellani, G. Pagnini
Journal of the Royal Society Interface, vol. 15. The Royal Society, 2018.

Complex multi-component systems, such as the crowded world of cell cytoplasms and membranes or complex networks with non-trivial links, are associated with the emergence of anomalous behavior in a measurable quantity diffusing over some medium, such as the spreading of some contaminant in a fluid or the diffusion of information in a complex network. Anomalous diffusion is described by means of processes evolving in time and whose quantity/time scaling is X ~ t^δ with $\delta \neq 1/2$. This last condition is usually a signature of Gaussian behavior, short-range (usually exponential) correlations and short memory (Markovian processes). On the contrary, anomalous diffusion is associated with long-range correlations, long persistent or anti-persistent memory (non-Markovian processes). Distributions of the observed quantities can be both Gaussian or non-Gaussian. This paper deals with the diffusive properties of the cell, which are crucial for the correct functioning of the cell biochemical networks (metabolomics). In fact, diffusion affects reaction rates through the probability that two or more reacting molecules meet each other. The great advancement in fluorescence-based microscopy enables researchers to investigate the detailed motion of single molecules (Single Particle Tracking, SPT) with great accuracy. This very accurate SPT data revealed the emergence of anomalous non-Gaussian diffusion and the scientific community is now focused on the development of proper modeling approaches in order to identify the most appropriate statistical tools of data analysis, thus allowing for the correct interpretation of SPT data. This can have potential applications in diagnostics, as anomalies in the diffusion efficiency can be linked to the rising of some pathologies. In this work we propose a model that can overcome some limitations of previous models in correctly interpreting the SPT data. The model is based on a stochastic process describing an ensemble of heterogeneous particles moving in a medium at constant temperature (thermal bath). The heterogeneity is encoded in the populations of two dynamical parameters: the relaxation time and the diffusivity of velocity. We prove that, for proper distributions of these parameters, we can derive different models and reproduce different statistical features of SPT data. In the figure we report the case of a Gaussian model with long-range correlations. When the mean particle velocity reaches a stationary condition (bottom panel), the diffusion reaches the asymptotic anomalous scaling (top panel).
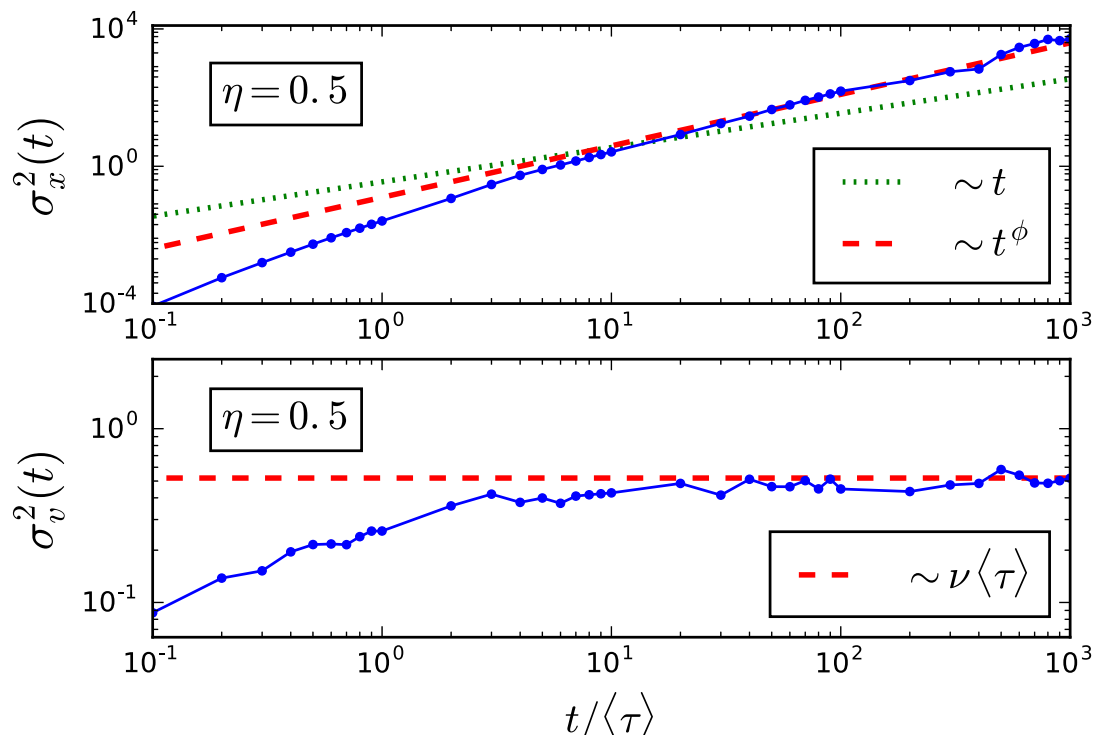
How do detected objects affect the noise distribution of terahertz security images?

Z. Wang, M. Hu, E.E. Kuruoglu, W. Zhu, G. Zhai
IEEE Access, vol. 6. IEEE, 2018.

The purpose of this paper is to analyze how detected objects affect the noise distribution of terahertz (THz) security images. Noise in THz image caused by hardware deteriorates the image quality seriously, limiting the application. In addition, there are a few papers on the noise analysis of THz screenings. Due to the special attributes of the THz image compared with the natural image, an alpha-stable distribution is used to fit the noise of THz image instead of the commonly-used Gaussian distribution. The database used in this paper is composed of 181 THz image cubes with a test object as well as two empty image cubes. After analyzing the four parameters of alpha-stable distribution, we can observe that the noise patterns of THz images are indeed different from those of natural image obtained by RGB camera. The possible reasons are given based on the principles of the THz imaging device. The analysis of the distribution of four parameters of alpha-stable model demonstrates that there exists a nonlinear effect due to the change of reflected wave's pattern caused by the body structure. This paper provides an efficient and flexible model for THz images and a useful guidance for the design of THz image denoising algorithms and the development of imaging hardware.
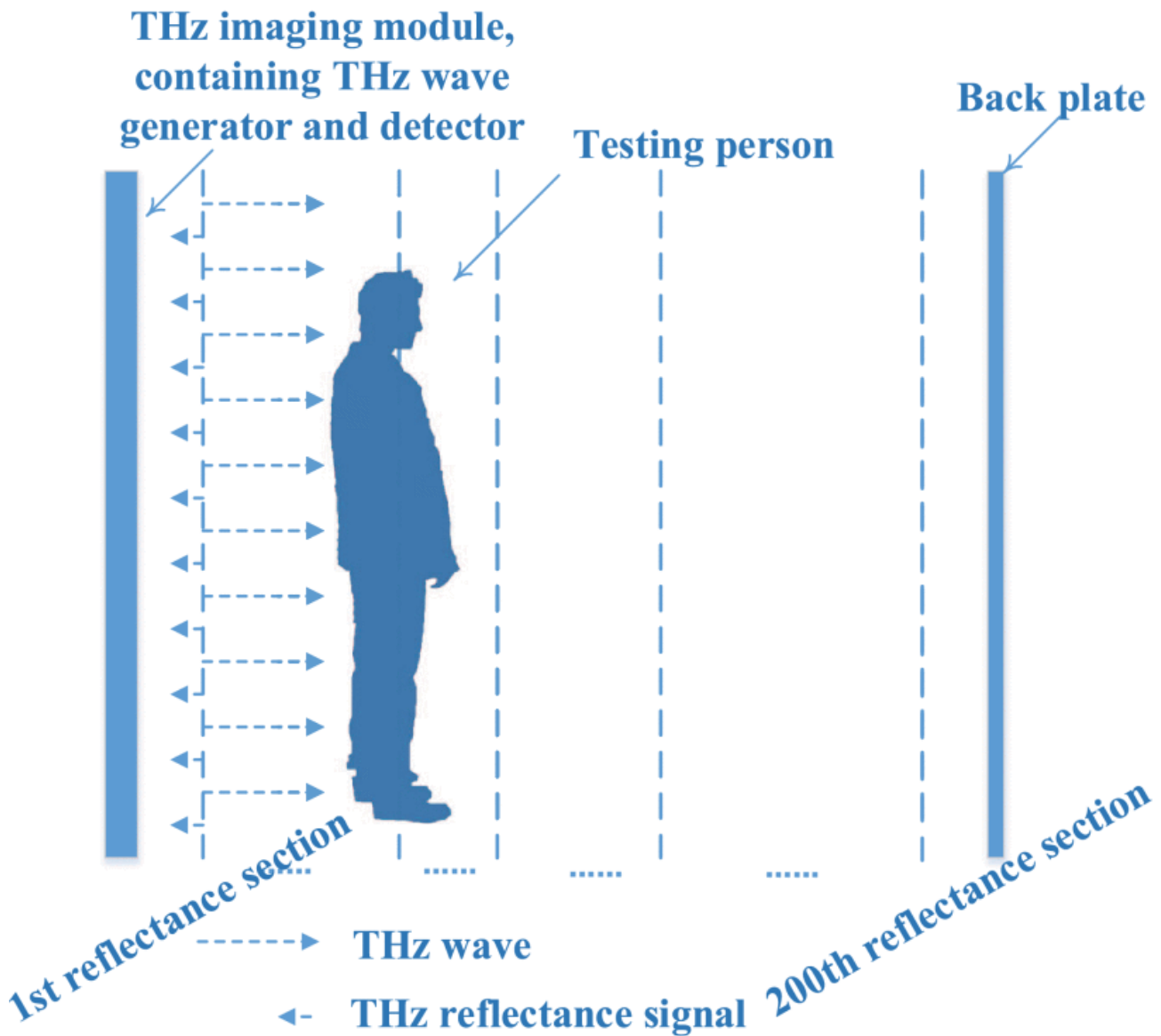
Real-Time smart parking systems integration in distributed ITS for smart cities

M. Alam, D. Moroni, G. Pieri, M. Tampucci, M. Gomes, J. Fonseca, J. Ferreira, G.R. Leone
Journal of Advanced Transportation. Wiley, 2018.
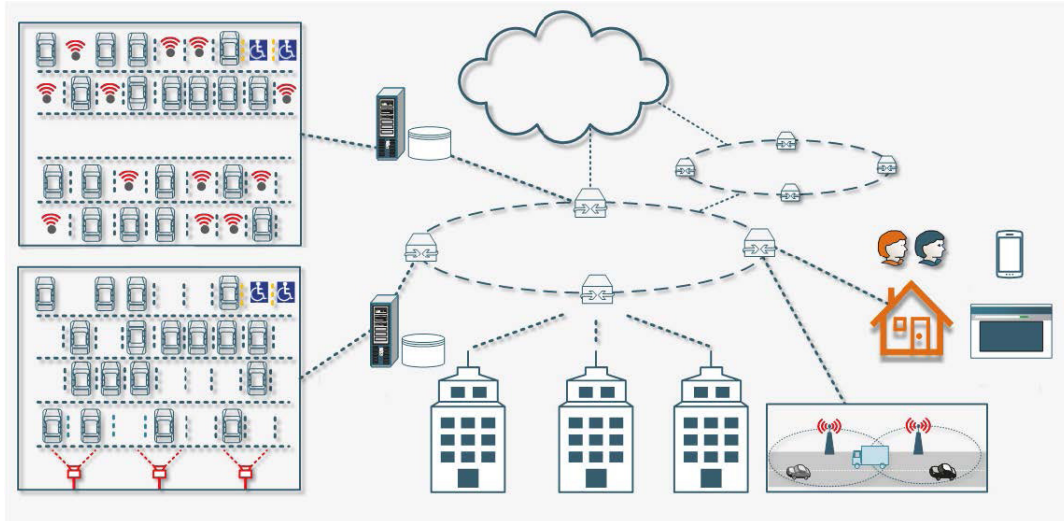
Intelligent Transportation Systems (ITS) have evolved as a key research topic in recent years, revolutionizing the overall traffic and travel experience by providing a set of advanced services and applications. These data-driven services contribute to mitigate major problems arising from the ever growing need of transport in our daily lives. Despite the progress, there is still need for an enhanced and distributed solution that can exploit the data from the available systems and provide an appropriate and real-time reaction on transportation systems. Therefore, in this paper, we present a new architecture where the intelligence is distributed and the decisions are decentralized. The proposed architecture is scalable since the incremental addition of new peripheral subsystems is supported by the introduction of gateways which requires no reengineering of the communication infrastructure. The proposed architecture is deployed to tackle the problem of traffic management inefficiency in urban areas, where traffic load is substantially increased, by vehicles moving around unnecessarily, to find a free parking space. This can be significantly reduced through the availability and diffusion of local information regarding vacant parking slots to drivers in a given area. Two types of parking systems, magnetic and vision sensor based, have been introduced, deployed, and tested in different scenarios. The effectiveness of the proposed architecture, together with the proposed algorithms, is assessed in field trials.
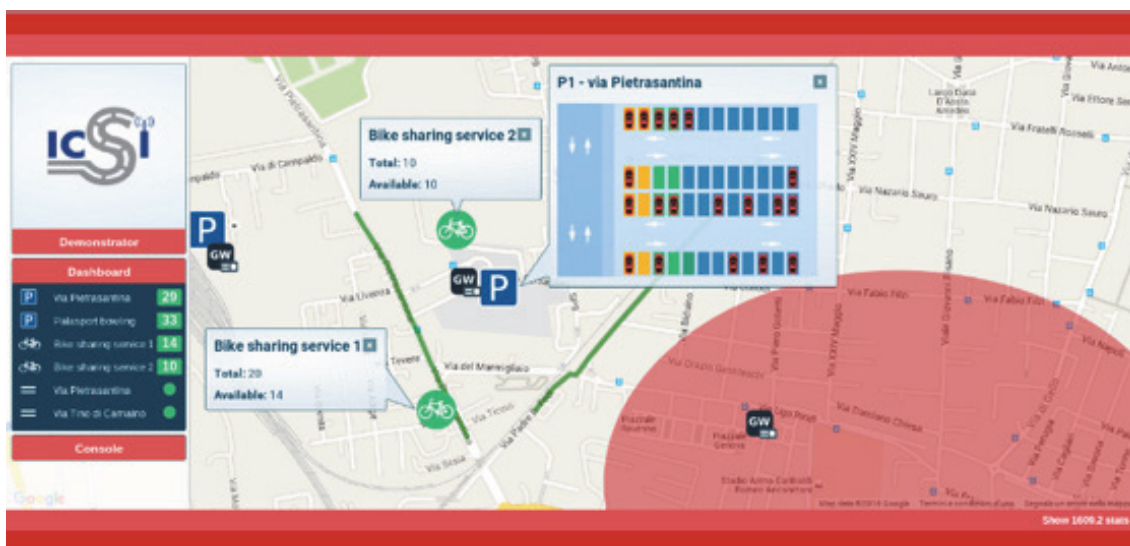
Metamolds: computational design of silicone molds

T. Alderighi, L. Malomo, D. Giorgi, N. Pietroni, B. Bickel, P. Cignoni
ACM Transactions on Graphics, vol. 37. ACM, 2018.

We propose a new method for fabricating digital objects through reusable silicone molds. Molds are generated by casting liquid silicone into custom 3D printed containers called metamolds. Metamolds automatically define the cuts that are needed to extract the cast object from the silicone mold. The shape of metamolds is designed through a novel segmentation technique, which takes into account both geometric and topological constraints involved in the process of mold casting. Our technique is simple, does not require changing the shape or topology of the input objects, and only requires of-the-shelf materials and technologies. We successfully tested our method on a set of challenging examples with complex shapes and rich geometric detail.

FlexMaps: computational design of flat flexible shells for shaping 3D objects

L. Malomo, J. Pérez, E. Iarussi, N. Pietroni, E. Miguel, P. Cignoni, B. Bickel
ACM Transactions on Graphics, vol. 37. ACM, 2018.

We propose FlexMaps, a novel framework for fabricating smooth shapes out of flat, flexible panels with tailored mechanical properties. We start by mapping the 3D surface onto a 2D domain as in traditional UV mapping to design a set of deformable flat panels called FlexMaps. For these panels, we design and obtain specific mechanical properties such that, once they are assembled, the static equilibrium configuration matches the desired 3D shape. FlexMaps can be fabricated from an almost rigid material, such as wood or plastic, and are made flexible in a controlled way by using computationally designed spiraling microstructures.
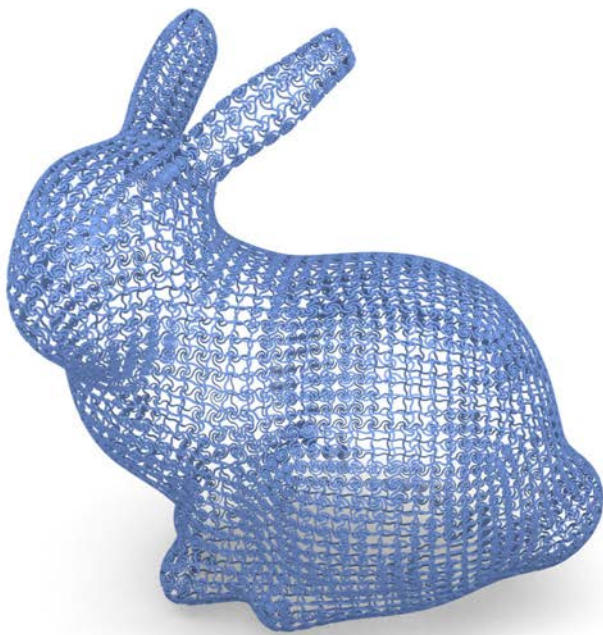
The influence of environmental parameters on the dynamic behaviour of the San Frediano bell tower in Lucca

R.M. Azzara, G. De Roeck, M. Girardi, C. Padovani, D. Pellegrini, E. Reynders
Engineering Structures, vol. 156. Elsevier, 2018.

This paper aims at assessing the influence of environmental parameters on the modal characteristics of age–old masonry constructions. The results of a long–term ambient vibration monitoring of the San Frediano bell tower in Lucca (Italy) are reported. The tower, dating back to the 11th century, has been fitted along its height with four triaxial seismometric stations, which were left active for about one year. Data from the monitoring system have been processed via the Stochastic Subspace Identification Method in order to identify the tower's modal characteristics and their variations over the year. The dependence of the tower's frequencies on the ambient temperature was first studied and simulated via simple auto–regressive models. Then, some output–only models based on the principal component analysis (PCA) were applied, under the hypotheses of both linear and nonlinear (Kernel PCA) dependence of the natural frequencies on the unknown environmental parameters. The results indicate PCA to be an effective tool for detecting changes in the dynamic characteristics of masonry constructions.
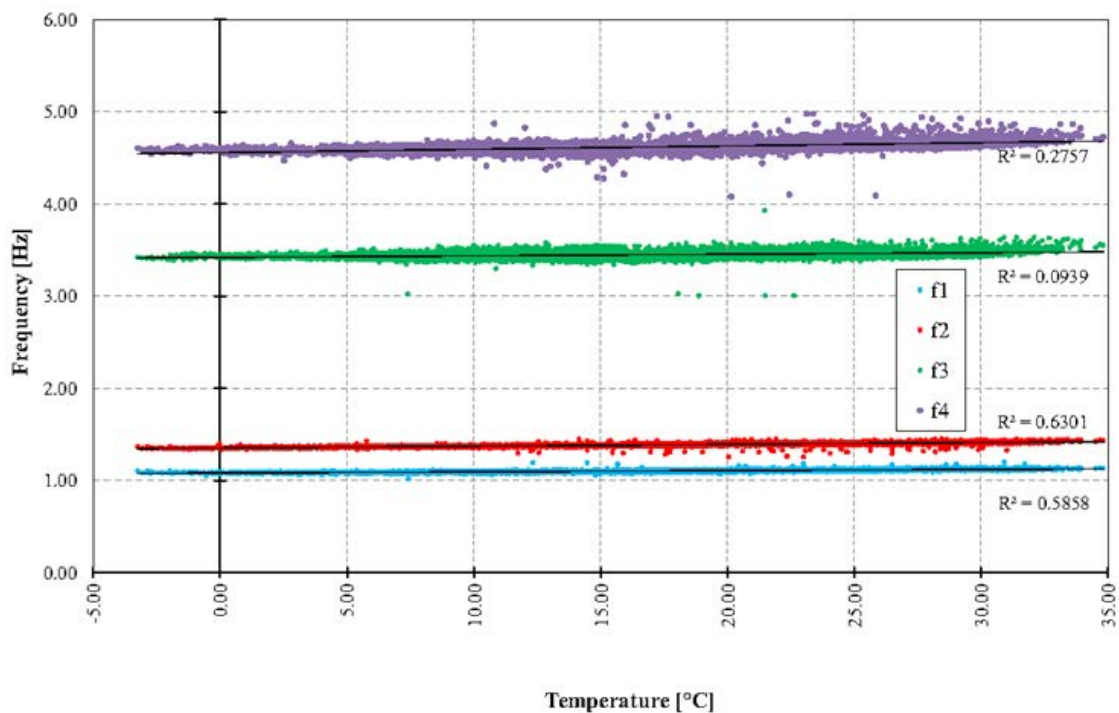
Modal analysis of historical masonry structures: linear perturbation and software benchmarking

D. Pellegrini, M. Girardi, P.B Lourenço, M.G. Masciotta, N. Mendes, C. Padovani, L.F Ramos.
Construction and Building Materials, vol. 189. Elsevier, 2018.

The mechanical behavior of masonry materials has a common feature: a nonlinear behavior with high compressive strength and very low tensile strength. As a consequence, old masonry buildings generally present cracks due to permanent loads and/or accidental events. Therefore, the characterization of the global dynamic behavior of masonry structures should take into account the presence of existing cracks. This paper presents a numerical approach coupling linear perturbation and modal analysis in order to estimate the dynamic properties of masonry constructions, taking into account the existence of structural damage. First, the approach is validated on a masonry arch subjected to increasing loads, via three FE codes. Then, the same procedure is applied to a real masonry structure affected by a severe crack distribution.
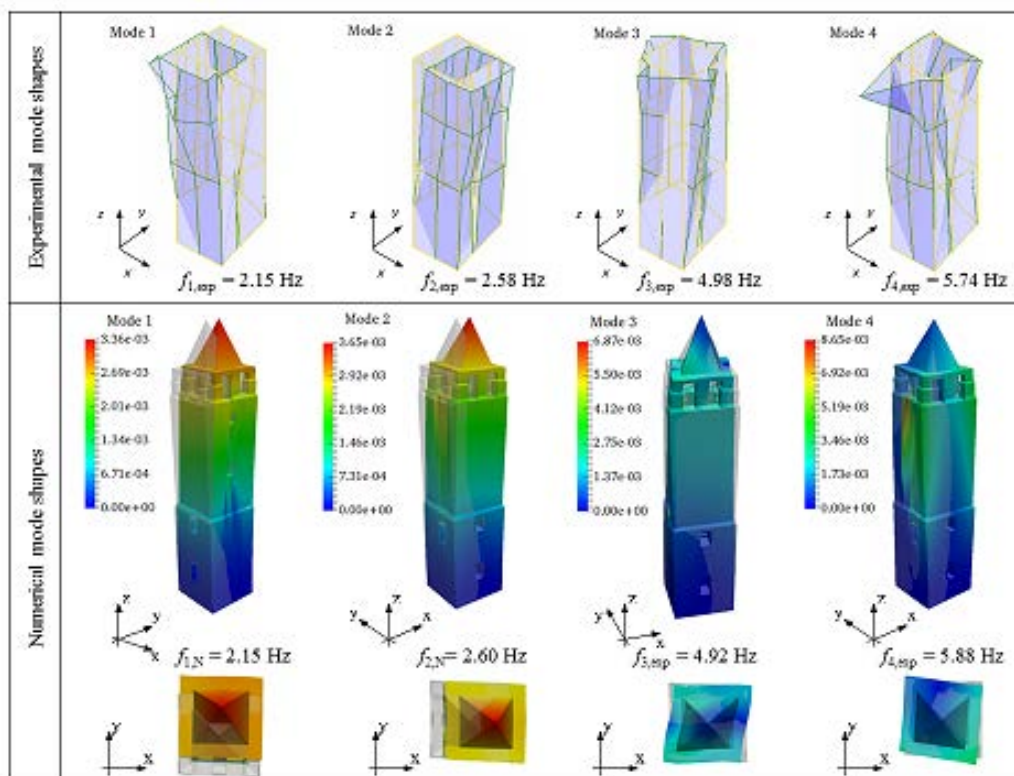
Evaluating the environmental criticality of massive objects in LEO for debris mitigation and remediation

C. Pardini, L. Anselmo

Approximately 95% of the mass in Earth orbit is currently concentrated in about 6700 intact objects, of which nearly 80% are abandoned and more than 90% cannot be maneuvered. The intact objects abandoned in low Earth orbit (LEO) above 650 km, i.e. with an average residual lifetime of more than 25 years, represent the main potential mass reservoir for the generation of new detrimental orbital debris in case of mutual collisions with the existing debris environment, taking into account that an 800 g impactor may be sufficient, in principle, to shatter a 1000 kg spacecraft or rocket stage.

Since the 1980's, several mitigation measures were promoted and agreed at the international level in order to prevent the occurrence of new breakups in space and put under control the accumulation of mass abandoned in orbit, but unfortunately the level of compliance with such guidelines, requirements or standards is still far from satisfactory. Moreover, the appearance on the scene of space activity of new private and government actors from a growing number of countries makes the proper management of the circumterrestrial space a task of increasing complexity, taking also into account the rapid emerging of new potential applications, disrupting technologies and operational approaches quite different from the past.

In this rapidly evolving environment, it might be useful to have a simple and flexible instrument for evaluating the potential criticality for the environment of massive objects placed or abandoned in LEO. With this goal, in the last few years, a particular

effort was devoted to the development of various "criticality indexes", then applied for evaluating many families of rocket bodies and selected spacecraft. In this paper, with the underlining ambition to be simple, intuitive and relevant, from an environmental point of view, a couple of the most complete indexes were coherently applied in order to assess the potential criticality of the most massive objects abandoned in LEO. The results obtained are presented here in detail, also highlighting how these ranking approaches might be used both for debris mitigation, for instance to choose an appropriate disposal orbit for either spacecraft or upper stages to be dismissed at the end-of-life, and for debris remediation, as a guide in the selection of the most relevant targets for active debris removal, if and when such missions will become practicable.
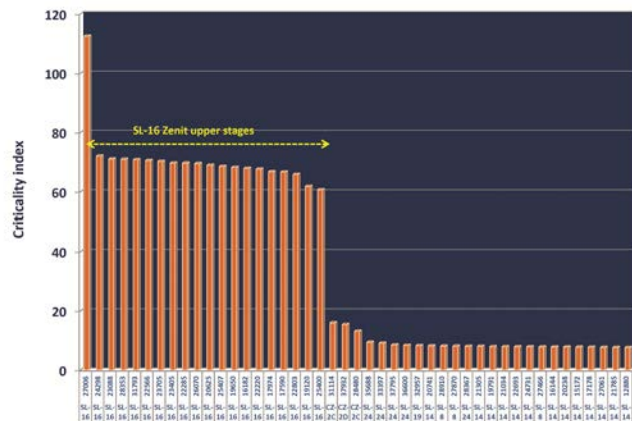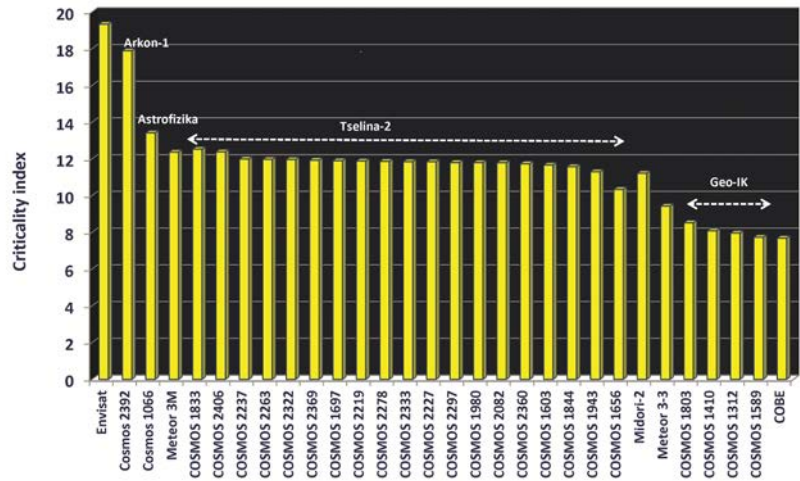
VoxLogicA: a tool for declarative spatial-logical image analysis

How can domain experts in (medical) image analysis formalise, execute, improve, and share their methods -- for instance, to identify brain tumours in 3D Magneto-Resonance scans -- with solid guarantees that their findings are portable, predictable and reproducible, and with minimal requirements on their skills and expertise in computing?

VoxLogicA is an instrument designed to support image analysis with an emphasis on simplicity, and is focused on producing explainable and implementation-independent results. A VoxLogicA session is a textual specification of analysis, employing a combination of spatial features (distance between regions, or inter-reachability), with texture similarity, statistical, and imaging primitives.

VoxLogicA sessions are written using a declarative logical language, named ImgQL ("Image Query Language"), inspired by widely recognised appliances such as the "Structured Query Language" (SQL) for databases, with strong mathematical foundations rooted in the area of Spatial Logics for Topological Spaces.

VoxLogicA is a publicly distributed, free and open source software. At its heart lies a "model checker", that is, a very efficient computation engine for logical queries, exploiting advanced techniques such as memorization, and multithreading, to deliver top-notch performances.

In recent research, as part of a collaboration between the "Formal Methods and Tools" group of ISTI-CNR, and the Azienda Ospedaliera Universitaria Senese, VoxLogicA was used to produce a specification of just ten lines of text, that can identify Glioblastoma in a 3D Magneto-Resonance scan in 8 seconds, on a standard laptop. For comparison, an expert radiotherapist takes about half an hour to perform this task.

The same procedure has been applied to about 200 cases (the well-known "BRAin Tumour Segmentation (BRATS) challenge" dataset). The accuracy of the results obtained can be measured; the new procedure scores among the top ranking methods of the BRATS challenge in 2017 -- the state of the art in the field, dominated by machine-learning methods -- and is comparable to manual delineation by human experts.

The intention in the near future is to extend this work, both in the direction of clinical case studies, and to embrace other computational approaches, which can be coordinated and harmonised using high-level logical specifications. A forthcoming publication introducing the tool and its applications to glioblastoma segmentation will be presented at the "25th International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS)", affiliated to "European Joint Conferences on Theory and Practice of Software (ETAPS)":
G. Belmonte, V. Ciancia, D. Latella, M. Massink. "VoxLogicA: a Spatial Model Checker for Declarative Image Analysis".
The source code and binaries of VoxLogicA are available at
https://github.com/vincenzoml/VoxLogicA
together with a simple example of a 2D background removal task, intended as a tutorial for the tool.

Contact: Vincenzo Ciancia, FMT Lab
vincenzo.ciancia@isti.cnr.it
https://github.com/vincenzoml/VoxLogicA
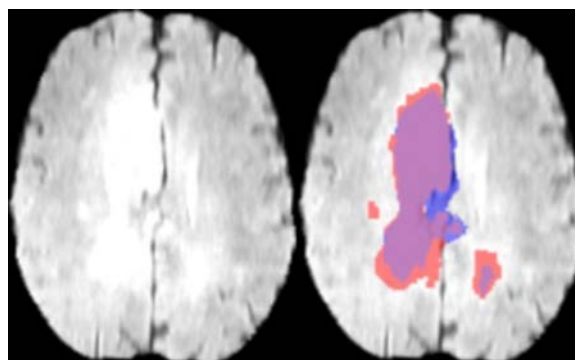

```
let growTum    = grow(hyperIntense,veryIntense)
let tumSim     = similarFLAIRTo(growTum)
let tumStatCC  = flt(2.0,(tumSim > 0.6))
let tumFinal   = grow(growTum,tumStatCC)
```

Chromstruct V4.2

Reconstruction of 3D chromatin structure from chromosome conformation capture data

This Python (v.2.7.10) code provides an estimate of the 3D structure of the chromatin fibre in cell nuclei from the contact frequency data produced by a "Chromosome conformation capture" experiment. The only input required is a text file containing a general real matrix of contact frequencies. The code features a GUI where all the tuneable parameters are made available to the user. The fibre is divided into independent segments whose structures are first estimated separately and then modelled as single elements of a lower-resolution fibre, which is treated iteratively in the same way until it cannot be divided anymore into independent segments. The full-resolution chain is then reconstructed by another iterative procedure.

The software, released under the GNU-GPL v.3 licence, is registered with the following DOI: 10.13140/RG.2.2.26123.39208

Contact: Emanuele Salerno, SI Lab
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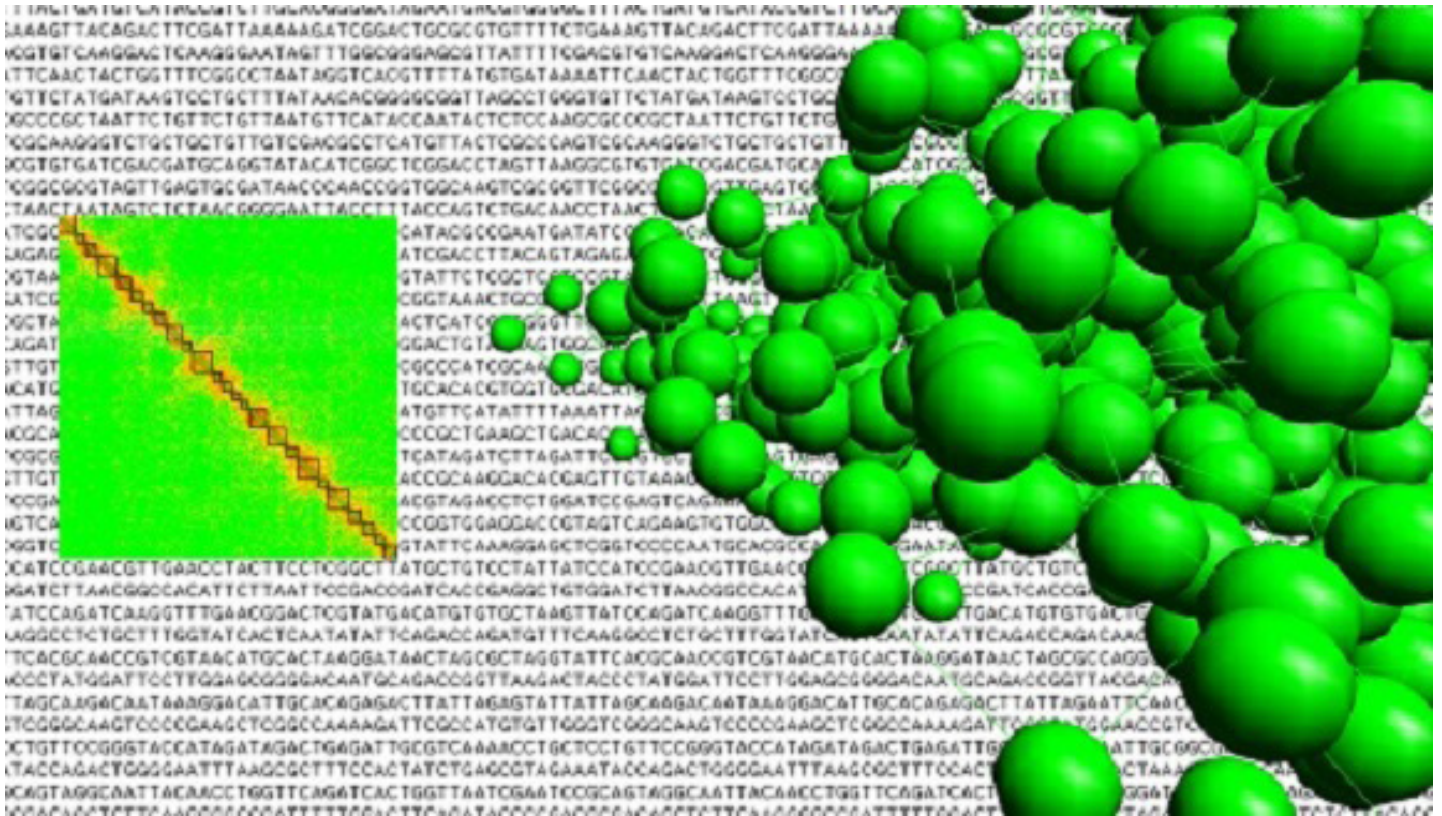
Long-term crack monitoring in cultural heritage

Enhancing the intelligence of Unmanned Aerial Vehicles

Architectural heritage preservation and dissemination is a very important topic in Cultural Heritage. Since ancient structures may present areas which are dangerous or difficult to access, Unmanned Aerial Vehicles (UAVs) may provide smart solutions for safe and fast data acquisition.

In the framework of MOSCARDO, a project funded by the Tuscany region, several aspects of long-term structural monitoring of our architectural heritage are considered. The Signals and Images laboratory of ISTI-CNR focused on the long-term monitoring and measuring of missing or deformed structural elements, cracks and fissures. Nowadays, visual inspection is the most commonly used technique to detect damage or to evaluate variations over time. However, this technique can be time consuming and expensive, and is not always possible if the access to critical locations is forbidden for safety reasons. The main case study in this project is the "Fortezza Vecchia" in Livorno, an ancient fortress whose walls are partially surrounded by the sea. A very important feature of the cracks along these walls is that their sides are quite far apart and definitely not level. This makes it very difficult to obtain absolute and accurate measurements of the size of the cracks with standard methods.

For this kind of structure, irregular, outdoor, subject to environmental agents and to seasonal changes, we decided to use markers (which are planar, square objects, set on the structure) to provide complete, stable 3D information about specifically identified points along the crack, to be tracked over time. A set of about 10 high resolution images of each crack are acquired, and the following data are computed:

(i) the set of 3D coordinates of each marker's corners;

(ii) the set of the distances between the barycenters of each pair of markers;

(iii) the angle variations between the reference frame associated with each marker.

Our method is minimally invasive, and can provide an optimal set of reference points using UAV for data acquisition, enabling a fast and highly repeatable data acquisition, even in difficult to access areas, thus reducing costs and risks. The method has been tested over a period of three months, with acquisitions every two weeks.

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Innovation in the building supply chain

EDuCO-LAB Project, LAB of Innovative Construction Education

The EDuCO-LAB Project, LAB of Innovative Construction Education was funded by Regione Toscana on Axis C of the FSE POR 2014-2020.

The project had as a main objective the design of training activities aimed at the development of technical skills in the construction sector: in particular, individual skills relevant to the labour market.

The project involved 6 classes of the Istituto Superiore Buontalenti-Cappellini-Orlando of Livorno for a total of 360 hours of didactic activities, conceived in an innovative way and with structured training activities

Motivated by the strong demand for technological innovation coming from the building supply chain and also by the need, forced by the regulations, to strengthen the sustainability of the works, the project introduced

training courses related to environment-friendly construction techniques, with high energy savings and equipped with innovative systems. In parallel to part of the classroom, a permanent construction lab was set up in which the students, in protected situations, tried their hand at realizing a real-estate module based on criteria of biocompatibility, sustainability and innovation plant.

The TQV Center, ISTI unit, coordinated the design and installation work of the plants present in the structure.

The electrical system, designed in the classroom by the students, has the characteristics of plant integration and is based on a single structured wiring. The components of

the plants are:

- networking / infrastructure
- comfort living
- digital electrical system on the bus
- security / safety
- AV control
- CTV
- system for audio diffusion based on music server and equipped with two zones of "sound walls"

The residential module is used for the educational activities of partner institutions and can be visited by appointment

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Teleconsultation at high altitude

During the summer of 2017, 702 patient-health specialist teleconsultations were performed in the Aosta Region of the Mont Blanc massif area, reducing the number of outpatient and emergency services

The Mont Blanc massif, bordering with three nations (Italy, France, Switzerland), attracts people from all over the world and eighty per cent of the territory of the Aosta Region, the Italian part of this area, is mountainous.

In this environmental context, and in the framework of the European project e-Rés@ mont (Interreg Alcotra), an innovative tele-cooperation and virtual teleconsultation system, the first of its kind in Europe, aimed at both the inhabitants and visitors to the area (tourists, hikers, mountaineers, etc.) was developed and a health care model was tested.

To test the system, a hospital and twelve Italian mountain huts and health care centres offered free medical assistance to all-comers during summer of 2017 and in part of the winter of 2018.

Nurses at the huts measured basic parameters such as blood pressure, heart rate, oxygen saturation and temperature, ultrasound, electrocardiograms and, using a tablet, sent all the data to a doctor on call at the hospital. The doctor checked the medical records, analysed the data and sent his diagnosis. The system also allowed the doctor to talk directly with the patient using an ad-hoc videoconference system.

702 teleconsultations were performed: besides improving the quality of life of the patients and enabling the treatment of emergency cases, the system reduced the number of specialist outpatient and emergency services, avoiding 30 emergency helicopter/ambulance rescue missions.

A clinical evaluation of acute respiratory insufficiency was also performed using our teleconsultation system by the Mountain Medicine Society of Nepal and the Himalayan Rescue Association at the world's highest hospital in Pheriche, Nepal, situated at an altitude of 4,371 metres, connected to ISTI-CNR, Pisa, Italy.
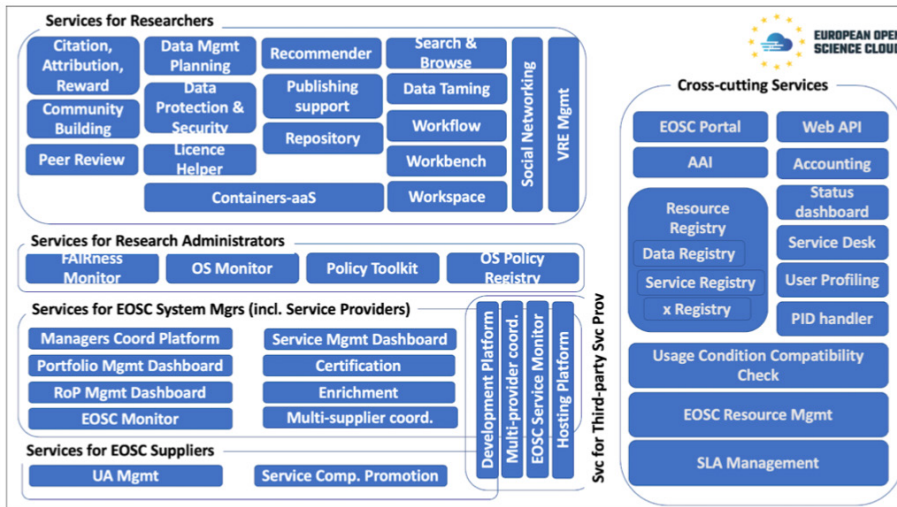
These results were presented at the "XII ISMM World Congress on Mountain Medicine Mountain Medicine in the Heart of the Himalayas" in Kathmandu, Nepal 21-24/11.

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Envisaging the European Open Science Cloud system architecture

The European Open Science Cloud (EOSC)[1] is an initiative promoting the development of a "virtual environment" for providing researchers and professionals in science with open and seamless services for storage, management, analysis and re-use of research data, across borders and scientific disciplines by federating existing scientific data infrastructures, currently dispersed across disciplines and the EU Member States. Its development involves the inclusion of a blueprint[2] of the IT system employed in its implementation. The ISTI-CNR team is responsible for leading the activity culminating in the development of this blueprint. The following features characterise the EOSC System:

(i) Its functionalities are provisioned as-a-Service, i.e. they are made available by online services operated by providers taking care of the technical and organisational approaches needed to deliver them;

1.   https://ec.europa.eu/research/open-science/index.cfm?pg=open-science-cloud

2. L. Candela, D. Castelli, F. Zoppi (2019) Final EOSC Service Architecture. EOSCPilot Deliverable D5.4 https://doi.org/10.5281/zenodo.3258797.

(ii) It is a highly distributed, evolving and heterogeneous hybrid cloud, i.e. it is an evolving mixture of on- and off-premises IT resources and organizations mobilized to deliver the services planned; (iii) Its operation and development is regulated by a set of Rules of Participation; (iv) It is modelled as an open and evolving System of Systems where the component systems providing services comprehend existing and emerging Research Infrastructures (including e-Infrastructures) and other types of Service Providers: L. Candela, D. Castelli, F. Zoppi (2019) Final EOSC Service Architecture. EOSCPilot Deliverable D5.4 https://doi.org/10.5281/zenodo.3258797; (v) EOSC services provision is based on an open and evolving set of EOSC Nodes spread across several organisations and regions; (vi) EOSC Services should promote and support FAIRness, e.g. the EOSC Services managing data should implement the FAIR principles.

The EOSC IT system is a complex and evolving platform expected to start taking shape in the next few years. Its development will both influence and be influenced by several economic and societal forces such as: (i) The community uptake both from consumption and production perspectives;

(ii) The IT services development market; (iii) Sustainability decisions taken by funders; (iv) Changes in the research environment (e.g. new metrics for the evaluation of researchers).

In the concluding remarks of the blueprint, the authors stressed that despite the "Minimal Viable Product" assumption taken, if we look at the services that infrastructures can currently make available to EOSC, we see that they do not yet cover the entire spectrum of minimal required functionalities. Aspects like community building and collaboration, recommendation, reward and attribution and many others related to the new open science vision are not yet on the radar of major e-Infrastructures or of the thematic Research Infrastructures. This gap is expected to be progressively filled in the coming years. Moreover, it is already anticipated that the EOSC services will largely change to reflect the evolving rules, policies and practices that the implementation of the Open Science vision will put in place.

As in any ecosystem, in order to obtain a good quality and sustainable system this change will have to be open to competition. Multiple providers will have the opportunity to offer their services and their resources and the "market" of researchers and other users will decide those that will survive and progress.

These considerations delineate a rapidly evolving landscape to which e-Infrastructures and Research Infrastructures will be required to promptly respond. This will also open a new market and a variety of new opportunities to third-party service providers.

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ISTI Young Researcher Award Edition 2018

The "Young Researcher Award" is an initiative by ISTI that aims at rewarding and making visible the work by young researchers at the Institute. The award (2018 is the sixth edition) selects the three best students in two categories (Young, for Ph.D. students and researchers less than 32 years old, and Young++, Ph.D. students and researchers less than 35 years old). The selection is made on the base of the number and quality of the publications produced in the previous year. The winners receive a small sum to support their research activity and have the possibility to present their research to their colleagues in the context of a cycle of seminars. For the 2018 the winners of the two categories were:

Young

Fabio Carrara

Riccardo Guidotti

Leonardo Robol

Young++

Davide Basile
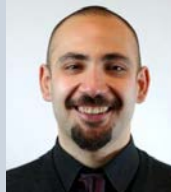
Luca Pappalardo

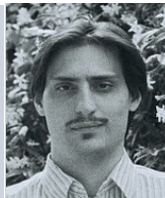Giulio Rossetti

Grants for Young Mobility

The ISTI Grants for Young Mobility (GYM) program enables young researchers (under 34) to carry out research in cooperation with foreign Universities and Research Institutions of clear international standing. It complements similar CNR programs. The winners in 2018 were:

Antonino Crivello

Giulio Masetti
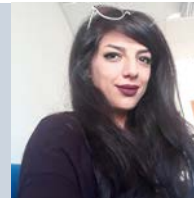
Parvaneh Parvin

Gaia Pavoni

Leonardo Robol

Eliana Siotto member of the Advisory Board of the Tuscany platform "Technologies-Cultural Heritage and Culture"

Eliana Siotto, (VC Lab) was the winner of the selection procedure for the awarding of no. 5 individual assignments of "Expert in policies and administration of cultural assets and activities" for the creation of an Advisory Board of the regional platform "Technologies-Cultural Heritage and Culture". She will provide specialized support in identifying the need for innovation and new technologies for the management of Tuscany cultural heritage, for activities related to its conservation, management, and enhancement with particular attention to the goal of increasing the cultural participation of citizens. The ultimate goal is to promote technology transfer to the cultural heritage sector. http://www.irpet.it/archives/49679

Best paper award 2018

The paper "A Compact Representation of Relightable Images for the Web" by Federico Ponchio, Massimiliano Corsini and Roberto Scopigno (VC Lab) has been conferred with the Best Paper Award at ACM Conference on Web3D Technology 2018 (Poznan, Poland, June 20-22, 2018).

Distinguished research paper award at the RE'18

The paper "Learning from Mistakes An Empirical Study of Elicitation Interviews performed by Novices" by Muneera Bano, Didar Zowghi, Alessio Ferrari, Paola Spoletini, Beatrice Donati has been conferred with the Distinguished Research Paper Award at the 26th IEEE International Requirements Engineering Conference (RE'18 - August 20-24, 2018, Banff, Canada).

Test of time Award

Test of Time Award for the paper "Sorting out the Document Identifier Assignment Problem" by Fabrizio Silvestri (HPC Lab) at the European Conference on Information Retrieval - ECIR 2018 (26-29 March 2018 - Grenoble, France). The Test of Time Award recognizes research that has had long lasting influence, including impact on a subarea of information retrieval research, across subareas of information retrieval research, and outside of the information retrieval research community (e.g. non-information retrieval research or industry).

E. Salerno associate editor of IEEE Transactions on image processing

Emanuele Salerno has been elected associate editor of the journal IEEE Transactions on Image Processing for the term 1 June 2018 - 1 June 2021. https://signalprocessingsociety.org/publications-resources/ieee-transactions-image-processing/

Ercan E. Kuruoglu has been reelected to EURASIP

EURASIP is the biggest Signal Processing/ Data Analysis professional organisation in Europe. It has eight Special Area Teams on critical areas of Signal Processing. BISA SAT covers a broad area of image & signal processing dedicated to biomedical applications in medicine, biology, physiology, neurosciences and genetics. The BISA SAT aims to actively promote synergies at the interdisciplinary interface where advanced imaging and data processing meet with biomedical sciences. In addition to image & signal processing tailored to biomedical applications, it also covers the emerging field of analytics, where learning from this type of data is pursued. The BISA SAT actively fosters the emergence of a biomedical community within EUSIPCO and reach out to other scientific communities.

SAT members are elected by the current SAT members upon nomination by a current SAT member. The term of the SAT members is 3 years and can only be renewed once. Ercan Kuruoglu was nominated for the second term by the Chair of BISA SAT and for the first term by the President of EURASIP (European Association for Signal Processing).

https://www.eurasip.org/index. php?option=com_content&view=article&id =151&Itemid=1151

Start Cup Toscana 2018

Start Cup Toscana 2018 (http://startcup.ilo-nova.eu/it), a contest among entrepreneurial ideas sprouting from regional research activities was held on October 30 at the Auditorium of Sant'Apollonia, in Florence.

The BeWize group from the CNR of Pisa, represented by Sara Colantonio of SI-Lab, was ranked second on the podium for having developed a sensorized, interactive and intelligent mirror named "Wize Mirror" dedicated to the monitoring of cardio-metabolic risk.

The top three winners have been awarded with a cash prize aimed at developing their project for market launch and with participation in the "Premio Nazionale per l'Innovazione" (http://www.	pnicube.it/ premio-nazionale-innovazione/), which was held in Verona on November 29th and 30th.

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ISTI-contributed Planck Mission receives the Gruber Cosmology Prize for precise measure of universe's contents and contours

"The Planck team, and its Principal Investigators Nazzareno Mandolesi and Jean-Loup Puget, are the recipients of the 2018 Gruber Cosmology Prize. From 2009 to 2013 the European Space Agency's Planck observatory collected data that has provided cosmology with the definitive description of the universe on the largest and smallest scales.(...) The Gruber International Prize Program honors individuals in the fields of Cosmology, Genetics and Neuroscience, whose groundbreaking work provides new models that inspire and enable fundamental shifts in knowledge and culture." ... "The Prize will be awarded on August 20, at the General Assembly of the International Astronomical Union, in Vienna, Austria" (excerpts from the Gruber Foundation press release: https://gruber.yale.edu/cosmology/press/2018-gruber-cosmology-prize-press-release).

The "Planck Surveyor Satellite" mission has been measuring the anisotropies of the cosmic microwave background radiation with unprecedented accuracy and resolu-

tion, thus allowing cosmologists to establish new figures for the matter-energy content and the geometry of the Universe.

From 2000 to 2014, ISTI's Signal and Images Lab has been contributing the mission with methods and algorithms to isolate the cosmological signal from the other astrophysical sources originated in our Milky Way and the other galaxies. This was an essential task for measurement accuracy, for

which the project has dedicated much of its effort during the pre-launch phase. Emanuele Salerno and Anna Tonazzini of SI-Lab are part of the Planck Scientist Collaboration.

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https://gruber.yale.edu/planck-scientists

New chair of the IADC Mitigation working group

Luciano Anselmo appointed at the 36th plenary meeting

At the end of the 36th Plenary Meeting of the Inter-Agency Space Debris Coordination Committee (IADC), held in Tsukuba, Japan, from 5 to 8 June 2018, Luciano Anselmo became Chair, for a two-year term, of the Working Group 4, mainly in charge of reviewing and drafting mitigation guidelines for addressing the problem of space debris.

The IADC is the main international governmental forum for the worldwide coordination of activities related to the issues of

man-made and natural debris in space. Currently consisting of 13 space agencies, its primary purposes are to exchange technical information on space debris research activities, to facilitate opportunities for cooperation in space debris research, to review the progress of ongoing cooperative activities, and to identify debris mitigation options. It also plays a prominent role in advising the international community, for instance the Committee on the Peaceful Uses of Outer Space (COPUOS) of the United Nations.

In the new position, Luciano, a staff researcher of the Space Flight Dynamics Laboratory, will coordinate the activities of the Working Group 4 during a period characterized by great changes in space activities and new challenges in debris mitigation.

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ESA space situational awareness advisory group

Luciano Anselmo appointed as a member for Space Debris and Clean Space

At the end of 2018, Luciano Anselmo was invited to become a member of the Space Situational Awareness (SSA) Advisory Group of the European Space Agency (ESA). The Advisory Group provides independent advice to ESA on operational, scientific and technical aspects of SSA activities, with a balanced representation for the different Space Safety Program areas, namely Space Weather, Space Debris and Clean Space, and Planetary Defense.

Luciano, a staff researcher of the Space Flight Dynamics Laboratory, was appointed to serve as a member in the Space Debris and Clean Space thematic area for a period of three years.

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New IAA corresponding member

Carmen Pardini elected for Engineering Sciences

In July 2018, Carmen Pardini was elected Corresponding Member of the International Academy of Astronautics for Section 2 – Engineering Sciences. The International Academy of Astronautics (IAA), founded in Stockholm, Sweden, on 16 August 1960, is an independent organization of distinguished individuals elected by their peers for their outstanding contributions to astro-

nautics and the exploration of space. It promotes the development of astronautics for peaceful purposes and works closely with the International Astronautical Federation and with national and international space agencies.

Carmen, a staff researcher of the Space Flight Dynamics Laboratory, was nominated

and elected in recognition of her long activity in space mission analysis, orbital debris modeling and mitigation, and reentry predictions of uncontrolled and potentially risky space objects.

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New deputy chair of the PEDAS panel

Carmen Pardini appointed after the 42nd COSPAR scientific assembly

Further to the 42nd Scientific Assembly of the Committee on Space Research (COSPAR), held in Pasadena, California, from 14 to 22 July 2018, Carmen Pardini was appointed Vice-Chair of the COSPAR Panel on Potentially Environmentally Detrimental Activities in Space (PEDAS) for the period 2018-2022. The Committee on Space Research, chartered by the International Science Council (ISC), is the preeminent scientific society to promote international cooperation in space research.

PEDAS is concerned with perturbations of

the terrestrial and planetary environments resulting from space activities. Typical examples are: space debris in Earth orbit, release of chemicals in the Earth's atmosphere by rocket launches, perturbation of the lunar environment by manned activities as well as possible perturbation of the Martian environment by space activities. The Panel acts on an ad hoc basis to evaluate questions of environmental impacts by space activities alone or together with other relevant organizations, primarily to advise the international community, e.g., the Committee on the Peaceful Uses of Outer Space

(COPUOS) of the United Nations.

In the new role, Carmen, a staff researcher of the Space Flight Dynamics Laboratory, will also serve as the Deputy Science Officer for the organization of the PEDAS sessions at the next two COSPAR Scientific Assemblies.

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Speleonotte 2018

October 13, 2018, Castellana Grotte, Italy

In the Castellana caves (Bari), during the Speleonotte 2018, meeting Massimo Magrini presented his sound art project ''Olhon''. The aim of this project is to use field recordings made in special (and often extreme) locations to create audio presentations halfway between documentary and conceptual art. These field recordings require the development of special techniques and devices, with applications that often go beyond the mere sound-art field.

After the presentation of his artistic work, Massimo Magrini delivered a scientific seminar focusing on techniques for estimating the geometric characteristics of hypogeal environments through the analysis of the environmental sounds recorded in them.

By analyzing the audio recordings, made with digital recorders able to record very low frequencies, it is, in fact, possible to have a rough indication of the dimensions of sections of the caves. This analysis can be carried out combining different types of acoustic models: a "room-like" model, with typical stationary waves, a "resonant tube" model, a Helmholtz resonator model. The hypogeal acoustic has not yet been investigated in depth. A pioneer in this field was the Italian researcher and speleologist Giovanni Badino, who started years ago to design a system based on an anemometer placed at the entrance of the cave. His recent, premature death has interrupted this interesting type of study. Following his work, and using current technology, Massimo Magrini has proposed the use of a cheap, portable Bluetooth special microphone connected to a simple smartphone running an ad hoc analyzing app: in this way a speleologist could estimate the best path to choose during a mission in an unexplored cave.

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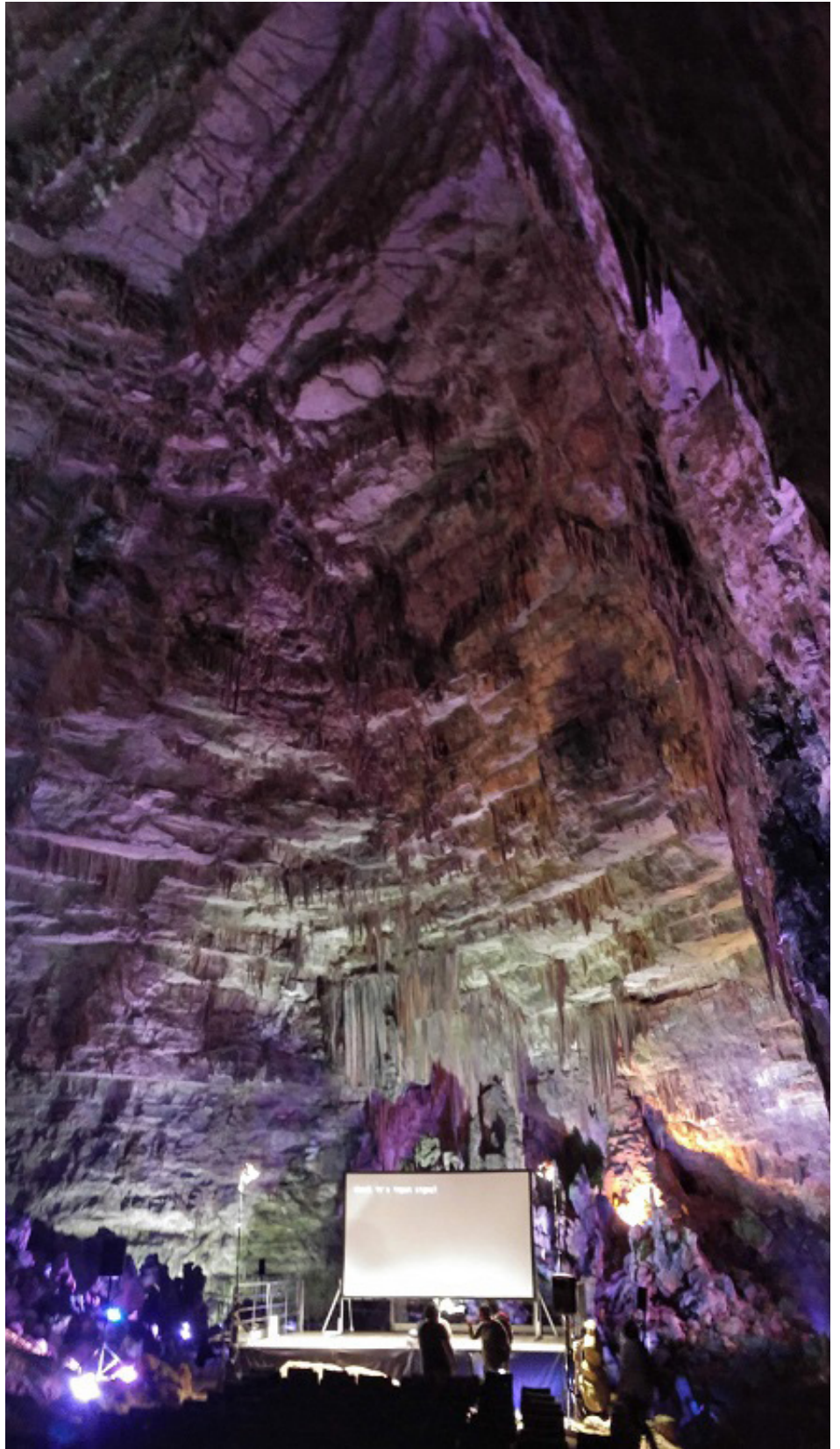
Artificial Intelligence meets Human Gesture & Music: talk and performance at TEDxLuxembourg 2018

October 26, 2018, Luxembourg

The first TEDx event hosted at the University of Luxembourg on 26 October 2018 gathered a diverse ensemble of speakers, performers and artists, each unique in their style and subject.

"Ideas 4.0" was the umbrella theme chosen for the University's introduction into the TEDx world. Because all kinds of human expression and arts have the power to inspire, TedxUniversityofLuxembourg invited a number of Luxembourgish and international artists on stage.

Starting the first session with a bang, Leonello Tarabella introduced the Collisions music project, in which artificial intelligence meets human movement and music. Leonello Tarabella, began working on his gesture recognition technology for computer music in 1995 through his activity as a researcher for the National Council of Research at ISTI-CNR, Pisa, Italy.

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Ph.D. Dissertations

Towards big data methods and technologies for official statistics

Author: Lorenzo Gabrielli, Dipartimento di Ingegneria dell'Informazione, Università degli Studi di Pisa
Supervisors: Fosca Giannotti, Mirco Nanni, Francesco Marcelloni

This thesis aims to demonstrate in a tangible way how mobile phone data, private vehicle tracks, and scanner data are useful for measuring complex systems.

The three main areas of application concerned use of Big Data: i) for measuring the presence within a territory through Data Mining techniques, ii) to now-casting socio-economic development of a country, and iii) for measuring the dynamics of cities.

First, a tool for real-time demography was developed demonstrating how to use mobile phone data over a wide area to achieve new Official Statistic indicators. The study showed how Big Data, either using mobile phone data or scanner data are useful and effective for carrying out a continuous census of the population.

Second, an analytical framework was proposed able to evaluate relations between relevant aspects of human behavior and the well-being of a territory. We found out that the diversity of human mobility is a mirror of some aspects of socio-economic development and well-being. Then, we showed how mobility features help to improve the performance of state-of-the-art methodology such as small area estimation methodologies.

Finally, how mobility interacts with the territory due to the movement of people was analysed. We proposed to use mobile phone data and GPS tracks for city government measuring the attractiveness of cities.

Furthermore, a data analysis approach aimed to identify mobility functional areas in a completely data-driven way was proposed.

The main findings of the thesis concern the statistical and ethical evaluation of results with official sources and showed that methodologies could be applied in other contexts and with different data sources as well. We showed how the geographic information contained in the data sources is incredibly useful to observe our society with a new "microscope" Thanks to the opportunity provided by the varied scientific context of SoBigData, the European Research Infrastructure for Big Data and Social Mining. the Ph.D. also contributed to develop and promote responsible data science because the ethical framework is considered as part of the CRISP model, not a problem to treat apart.

Mining predictive models for big data placement

Author: Marco Meoni, Dipartimento di Informatica, Università degli Studi di Pisa
Supervisors: Raffaele Perego, Nicola Tonellotto

Over the last few years, the historical usage data produced by the large infrastructure of the CMS experiment at CERN has recorded more than 5 Petabytes of raw storage. Above all, the problem of understanding and predicting dataset popularity is of primary interest for CERN.

The main contributions of this thesis include the following results:

1) we propose and implement a scalable machine learning pipeline, built on top of the CMS Hadoop data store, to predict the

popularity of new and existing datasets accessed by jobs processing any of the 25 event types stored in the distributed CMS infrastructure. Our experiments show that the proposed predictive models reach very satisfying accuracy, indicating the ability to correctly separate popular datasets from unpopular ones;

2) we propose a novel intelligent data caching policy, named PPC (Popularity Prediction Caching). This caching strategy exploits the popularity predictions achieved with our best performing classi-

fier to optimize the eviction policy implemented at each site of the CMS infrastructure. We assess the effectiveness of this caching policy by measuring the hit rates achieved by PPC and caching baselines such as LRU (Least Recently Used) in managing the dataset access requests over a two-year timespan at 6 CMS sites. The results of our simulation show that PPC outperforms LRU reducing the number of cache misses up to 20% in some sites.

A portable, intelligent, customizable device for human breath analysis

Author: Danila Germanese, Dipartimento di Ingegneria dell'Informazione, Università degli Studi di Pisa
Supervisor(s): Dott. Ovidio Salvetti, Prof. Luigi Landini, Prof. Francesco Marcelloni

Breath analysis allows for monitoring the metabolic processes that occur in the human body in a non-invasive way. However, despite its potential, only a few breath tests are commonly used in clinical practice. One of the reasons is related to standard instrumentation for gas analysis, e.g. gas chromatography, which is expensive, time-consuming and, often, difficult to use.

The aim of the project, carried out at Signals and Images Laboratory (SiLab) and in the framework of SEMEOTICONS (SEMEiotic Oriented Technology for Individual's CardiOmetabolic risk self-assessmeNt and Self-monitoring) European Project, was to develop the Wize Sniffer (WS), a low-cost, easy-to-use, gas sensor-based device able to accurately analyze human breath composition and to overcome the limitations of existing instrumentation for gas analysis.

In SEMEOTICONS, the WS was designed for detecting, in human breath, the molecules related to the noxious habits for cardio-metabolic risk. The clinical assumption behind the WS lay in the fact that harmful habits such as alcohol consumption, smoking, unhealthy diet cause a variation in the concentration of a set of molecules in the exhaled breath. By means of an array of metal oxide semiconductor gas sensors, a signal pre-conditioning module, a signal acquisition board and a multivariate statistical data analysis algorithm, the WS was able to estimate the individual's noxious habits and cardio-metabolic risk score on the basis of the analysis of the breath composition.

Given such good outcomes, another study was carried out. It aimed at evaluating WS diagnostic capabilities, in the field of chronic liver impairment, as the studies which involve e-noses in the identification of liver disease are still few. In this proof-of-concept study, which involved 64 subjects, the WS showed good diagnosis-oriented properties in discriminating the severity of liver impairment (absence of disease, chronic liver disease, cirrhosis, hepatic encephalopathy) on the basis of the detected breath ammonia.

Big data analytics for nowcasting and forecasting social phenomena

Author: Ioanna Miliou, Dipartimento di Informatica, Università degli Studi di Pisa
Supervisors: Dino Pedreschi, Salvatore Rinzivillo

One of the most pressing, and fascinating challenges of our time is understanding the complexity of the global interconnected society we inhabit. This connectedness is revealed in many phenomena: in the rapid growth of the Internet and Web, in the ease of global communication and trade, and in the ability of news and information as well as epidemics, trends, financial crises and social unrest to spread around the world. Ours is also a time of opportunity to observe and measure how our society works: Big Data originating from the digital breadcrumbs of human activities promise to let us scrutinize the ground truth of individual and collective behavior at an unprecedented detail in real time. With Big Data, we can describe and predict how humans and society work. We can use geolocated data to observe the behavior of a population, to build better cities with lower commuting times and lower pollution. We can exploit medical data to build classifiers able to help in diagnosing and curing diseases. We can use industrial data to improve the production processes, and create smarter and more secure factories. In this thesis, we introduce data-driven as well as model-driven approaches to predict different phenomena, from epidemics to socio-economic attraction. We use Big Data deriving from our everyday life as external proxies to nowcast and forecast the evolution of phenomena whose study relies only on historical data or data that come only with a significant lag. In our first major work, we use supermarket retail data as an external signal to predict the curve of seasonal influenza. We also study human movements that are inherently massive, dynamical, and complex to mine individual mobility patterns in order to study and predict the attraction of different socio-economic factors of human environment such as the future evolution of the airports in a region and the rise or death of industrial clusters. Finally, we attempt prediction in social networks, introducing the interaction prediction problem, trying to predict intra-community and inter-community interactions.

Understanding spreading and evolution in complex networks

Author: Letizia Milli, Dipartimento di Informatica, Università degli Studi di Pisa
Supervisors: Dino Pedreschi, Fosca Giannotti

Nowadays, the increasing availability of Big Data, describes our desires, opinions, sentiments, purchases, relationships and social connections, provides access to a huge source of information on an unprecedented scale. In the last decades Social Network Analysis, SNA, has received increasing attention from several, different fields of research. Such popularity was certainly due to the flexibility offered by graph representation: a powerful tool that allows reducing many phenomena to a common analytical framework whose basic bricks are nodes and their relations. Especially, the analysis of diffusive phenomena that unfold on top of complex networks is a task able to attract growing interests from multiple fields of research. Understanding the mechanism behind the global spread of an epidemic or information is fundamental for applications in a diversity of areas such as epidemiology or viral marketing. This thesis aims to understand spreading and evolution phenomena in complex networks. We developed two library frameworks: DyNetX, a package designed to model evolving graph topologies and a simulation framework, called NDlib, aimed to model, simulate and study diffusion phenomena that unfold over complex networks. This framework can be fruitfully used by different user segments, from developers to students as well as non-technicians. The purpose of this simulation framework is to empirically compare the effects of diffusion processes according to different diffusion models over several network topologies within different contexts. Covered models include classic and network epidemic models, threshold models and opinion dynamics models; the repertoire of models is extensible. NDlib is the first library that, leveraging DyNetX, allows the implementation of diffusion models explicitly designed to work on top of evolving network topologies. NDlib is about being released on SoBigData.eu. We also investigated related problems, including the early discovery of successful innovations, and the diminishing return effect in diffusion processes, leveraging on large, real datasets from diverse domains, such as retail and music.

Exploring effective publishing in the Web3D world

Author: Marco Potenziani, Dipartimento di Informatica, Università degli Studi di Pisa
Supervisors: Roberto Scopigno, Marco Callieri

Web3D is most certainly an intriguing world.

Its story has changed suddenly with the advent of WebGL, evolving from a slow and stagnant past to a dynamic and rapidly evolving present.

Unfortunately, this field experimented a quick and often chaotic growth, that has somehow shaped the directions of Web3D development, creating de-facto standards and solutions tailored to specific fields, or only focused towards mainstream publishing actions and thus unable to cope with the needs of more specialized and technical 3D users.

The aim of the thesis is to investigate the shortcomings and missing features of Web3D technology, as well as to propose a solution aimed at filling these empty spots.

We start by presenting an analysis of the state of the art of 3D web publishing, surveying the features provided by the major current approaches, useful to categorize the existing solutions and to cross-map them with the requirements of the different application domains.

Then, we exploit the result of our analysis of the Web3D and discuss the design and implementation of a flexible platform, aimed at providing an effective framework for the web presentation of specialized 3D content.

Our solution is tailored to cope with the needs of a challenging application context, Cultural Heritage. Therefore, it exploits highly efficient solutions for data transfer and rendering, intuitive interaction/manipulation paradigms, and features enabling trans-media elements connections.

To validate the proposed framework, the thesis presents the results of two specific interactive visualization applications, addressing different Web3D presentation needs: museum dissemination and scientific analysis.

Finally, we also tested our platform for implementing two service-oriented applications: a service for the easy publication of complex media types and a pipeline to rationalize and speed-up the publication of heterogeneous 3D datasets on a multimedia Digital Library.

Modelling, design and evaluation of a process-driven framework for workplace e-learning

Author: Subramanian Venkatapathy, Gran Sasso Science Institute
Supervisors: Antonia Bertolino, Guglielmo De Angelis

Workplace learners are particularly exigent and selective; they learn just what they need and perceive as useful only what can be applied to their tasks. Current Learning Management Systems (LMS) may not be effective for workplace learning. They focus mostly on managing the learning content for cohorts of learners with similar entry levels, and do not give proper emphasis to the process applied during learning. Approaches to workplace learning must be founded on the alignment of the educational content with the processes and tasks to be carried out. Hence, the need emerges for a paradigm shift in the design of workplace e-learning systems, towards a process-oriented learning approach.

Interestingly, alongside the demand for innovative approaches to workplace learning, a steady progress can be noticed in another thread of the organization called Business Process Management (BPM) where process-driven approaches are used in the design of information systems and to manage the collaboration activities of various stakeholders.

In this thesis, we propose that the BPM methodology be also utilized for the design of workplace e-learning systems and introduce a model called the Learning Path that can be used for the learning process. In BPM, the Business Process Model and Notation (BPMN) is widely used for modeling, implementation, execution and monitoring of business applications. Likewise, our Learning Path specification provides a method to add a learning pedagogy to the already existing BPMN model. We provide the theoretical definition of the Learning Path and the specification of a BPMLS architecture. To evaluate the method we applied the Technology Acceptance Model (TAM) to a prototype of BPMLS, so to have an evidence-based understanding on how users receive BPMLS as a new learning technology. The users positively agree to each of the TAM constructs that directly affected the technology acceptance of BPMLS. The highest value for acceptance that we got among the TAM variables is for the Perceived Usefulness. This result is encouraging because the Perceived Usefulness exerts the major influence on the actual use of the system.

To conclude, the methods proposed in this thesis can be expected to contribute to the new direction in the development and integration of learning in the organizations.

Social media data analytics for tourists' mobility modeling and prediction

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Supervisors: Dino Pedreschi, Mirco Nanni

Understanding and predicting human mobility is currently one of the most interesting and challenging objectives of big data analytics, with many scientific issues and large impact applications. In this context, the mobility of visitors within a touristic area (from small cities to whole countries) represents a very specific yet important case, with its own specificities and high economical and social impact. In this thesis, we aim to study methods and algorithms for modeling tourists' mobility in urban settings, with the twofold objective of better understanding the choice criteria adopted to plan the visit, and predicting the destinations of visitors, which can be valuable tools for city management and the simulation of what-if scenarios. The approaches considered in this work are tailored around social network data sources providing positioning information about their users, and in particular experimental evaluations are performed on Flickr data. In the first part of the work, two main driving criteria for choosing the next visited location of a user are considered: Willingness to move far away vs the popularity of the place to visit. Empirical results on Venice – which is a representative of massively touristic cities – suggest that both play an important role for most visitors, with some minorities almost exclusively driven by only one of them, and virtually nobody moving randomly. In the second and largest part of the thesis, we compare several sequence prediction approaches on the task of predicting the next point-of-interest in a user's itinerary. The candidate solutions include standard Hidden Markov Models (HMMs), Sequential Rule Mining (SRM), Recurrent Neural Networks (RNNs) and a Hybrid model that mixes the first two basic methods. Empirical evaluations suggest that HMMs and SRM have a limited accuracy in this kind of task, yet with complementary strengths that are successfully exploited by the Hybrid combination model reaching significant improvements. Finally, RNNs showed the best performances among all the approaches, in spite of the relatively limited size of the training dataset available.

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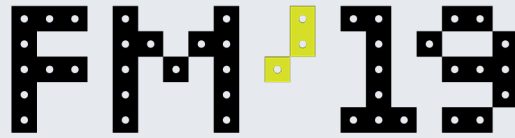**Research Staff (Tecnologo)**
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