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**The Current European
Digital Scenario**

EDITORIAL

**2024: Opening up to the new
year with excellent results**

Image Credit Daniele Fadda (Isti-Cnr)

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2024: Opening up to the new year with excellent results

2023 has been a dynamic year for ISTI with significant organizational changes and scientific achievements. Here below, I give a summary:

Organizational Highlights

Leadership Transition

As the term in office of the Director of the Institute ended on March 31, 2023, the process to select the next Director was triggered at the end of 2022. The scientific evaluation committee selected three candidates – Giuseppe Amato, Andrea Passarella, and Roberto Scopigno – who were interviewed by the governing body of CNR on 17 January 2024. Roberto Scopigno was selected and consequently nominated for a second term as Director of ISTI.

Renewal of the Internal Advisory Committee

The four-year term of the “Consiglio di Istituto” ended in November 2023 (this is an elected committee that advises the Director on any matters related to the management of the Institute). A new committee was elected by ISTI staff on 28 November, and the old and new members participated in a joint meeting on 11 December 2023.

The Director expressed gratitude for the outgoing committee’s valuable work. The section enclosed in the box labeled “Turnover in the composition of the Institute Council (2019-2023)” contains some reflections and experiences shared by members of the Institute Council.

Scientific Achievements

Budget Success

ISTI secured impressive funding in 2023, with the incoming budget increasing from the 5.8 million euros of 2022 to 12.2 mil-

lion euros. The success can be attributed in particular to effective participation in PNRR calls, resulting in 23 funded proposals.

European Commission Projects

ISTI also maintained strong participation in EU projects with 38 projects active in 2023, highlighting the institute’s continued success in securing funding at the European level.

PRIN Evaluation

ISTI achieved outstanding results in the evaluation of the PRIN calls launched by the Ministry of Research (MUR). The institute was awarded 13 projects in the PRIN 2022 call and 7 projects in the PRIN PNRR 2022 call; a total of 20 Italian funded projects. These projects are presented in the “New Projects” section of this issue.

Research Activity

Despite challenges posed by the ongoing global pandemic situation, ISTI evidenced high research productivity in 2023. The number of papers published in international journals and presented at conferences was higher than in the pre-COVID years, even improving over the scores of our previous record year: 2019.

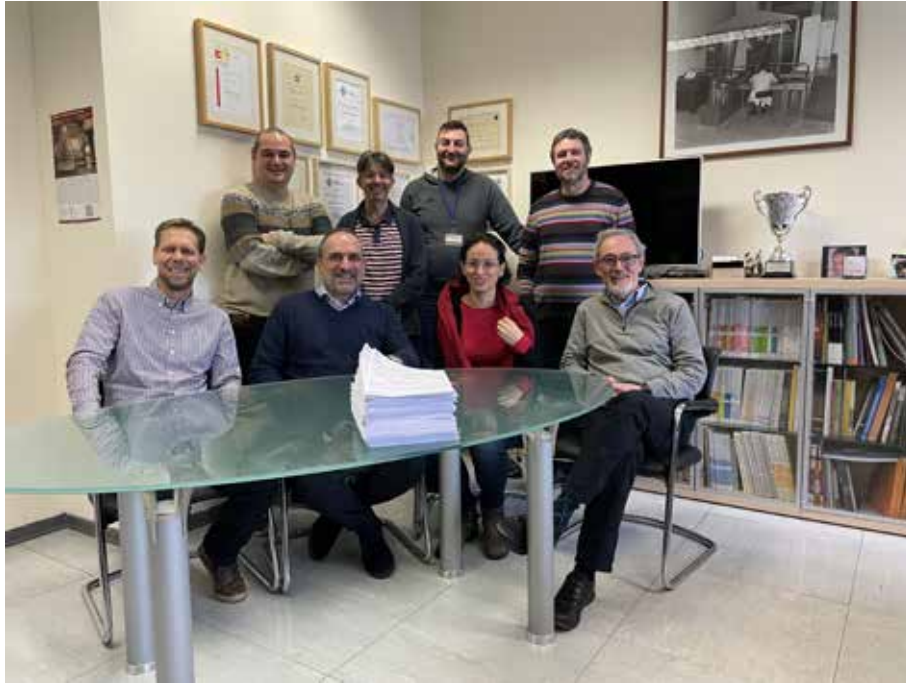
The 2023 figures, still incomplete at the date of writing (18 January), list 158 international journal papers and 172 international conference presentations.

For more detailed information on research results, see our website for a comprehensive overview (<https://openportal.isti.cnr.it/statistics/year-type>).

Overall, for ISTI, 2023 has been a year marked by robust organization, successful transitions, and notable achievements in securing funding and producing impactful research.

Congratulations to the Institute on a fruitful year, and best wishes for continued success in the future.

Contact: Roberto Scopigno, Director
roberto.scopigno@isti.cnr.it



The ISTI Advisory Council

Turnover in the composition of the Institute Council (2019-2023)

On December 11, 2023, the first meeting of the new Institute Advisory Council (Consiglio di Istituto - CI) was held in a joint session with the outgoing CI in order to facilitate the handover of duties.

The outgoing members (Giuseppe Amato, Daniela Giorgi, Franco Maria Nardini, Paolo Paradisi, Giorgio Oronzo Spagnolo, and Marco Tampucci replacing Brunella Falchi as of June 2023) described the work involved, the type of input required, and the ongoing activities. Over the last four years, the actions of the CI have included: the organization of meetings of junior researchers of the Institute with the Director of the Department; a round of presentations by ISTI researchers at Italian universities to contribute to a better understanding of ISTI's activities, to introduce opportunities for collaboration and training and to be more effective in our recruitment efforts; and – last but not least – the management of actions taken during the pandemic. An important contribution has been the introduction of the “social room”, designed as a space dedicated to social gatherings and informal work discussions in order to help create greater cohesion in the Institute and more intense sociability, a critical aspect after the Covid years and the frequency of smart working. The outgoing CI noted with pleasure that the room is used a lot and often. all the tables are occupied at lunchtime. One of the most important issues left to the new CI is to continue discussion on the best ways to manage the institute's considerable volume of projects.

The stated ambitions of the new CI (Massimiliano Corsini, Claudio Gennaro, Pasquale Pagano, Maria Antonietta Pascali, Marco Tampucci, Maurice ter Beek and Roberto Trasarti) are to promote interdisciplinary collaboration between the Institute's research laboratories but also to encourage the digitization of administrative procedures and decrease bureaucracy. Although several open issues and problems stem from choices made by CNR Headquarters and the MUR, efforts should be made to improve the local situation by encouraging constant dialogue between the Director and the Administrative, Technical and Research Staff. This should help to resolve problems and address future challenges, effectively. Additionally, in collaboration with other Advisory Councils of CNR institutes, the new CI intends to lobby CNR and MUR headquarters to reduce short-term contracts and provide more permanent work openings and promotions. A more efficient organizational structure for both recruitment and career progression at all staff levels is needed.

The Current European Digital Scenario

ISTI is the central node and coordinator of SoBigData RI (www.sobigdata.eu), a multi-disciplinary Research Infrastructure created with the aim of using Big Data to understand the complexity of society, offering no-profit services to researchers, industry, public bodies, and private citizens. The ultimate goal of SoBigData is to create a multidisciplinary scientific community which is consistent with the European vision for ethical, legal, and open data science.

The Research Infrastructure is currently working on building “The SoBigData Social Observatory”. This initiative collects, creates and updates indicators in order to publish periodic reports monitoring the evolution of systemic risks linked to the introduction of new technologies, following the European Digital Strategy priorities. In this context, the researchers have a pivotal role in the implementation of the new European rules, which have been designed to maximize the positive impact of their work on society.

We have written this article with the objective of giving an idea of the current European legislative framework for the digital field¹, so that researchers can understand the different scopes of the various Regulations and Directives adopted in the past few years and how the new rules can impact their activities when Big Data are concerned. For this reason, after examining the European Digital Strategy in general, we focus our analysis on the Digital Services Act, which provides researchers with new mechanisms to access online platforms’ data and detect systemic risks in the digital sphere. The idea that the smooth flow of data is essential to foster innovation is not new in the European Union: Regulation

1. This article examines the existing framework at the time of writing (January 2024). Our analysis focuses mostly on adopted Regulations, but we have discussed also the proposed AI Act, even though its final text has yet to be published and adopted by the European institutions.



(UE) 2016 (usually referred to as “GDPR”) is not only aimed at protecting personal data, but also at allowing and incentivizing its circulation in the EU, provided that all necessary safeguards are in place. The European Digital Strategy, which is one of the six priorities of the European Commission established in 2019, moves in this direction. The objective is to create a digital society in which the opportunities provided by the new technologies are exploited while European values such as fairness, freedom, equality and protection are fully implemented.

All the new Regulations and Directives which have been adopted or proposed in the past years in this sector must be understood with this fundamental idea in mind: on the one hand there is the need to use and share the data, on the other the risks connected to these activities must be addressed and constrained to protect not only individuals but society as a whole.

The European Strategy for Data proposed by the European Commission in 2020 thus aims at creating a single market for data that will ensure both Europe’s global competitiveness and its data sovereignty. Its legislative pillars are two Regulations: the Data Governance Act, which entered into force on June 23, 2023, and became fully applicable on September 24, 2023, and the Data

Act, which was formally adopted by the Council on November 27, 2023.

While the Data Act is focused on allowing the reuse of data generated by consumers and businesses using products (such as IoT devices) and services, the Data Governance Act is aimed at making more data available and facilitating data sharing across various sectors in European countries in order to leverage data potential. It also establishes the new European Data Innovation Board (“EDIB”) which will be nominated by the European Commission with the purpose of facilitating the sharing of best practices for the purposes of the Data Governance Act.

For public sector data, the most relevant EU law is the Open Data Directive (Directive (EU) 2019) which establishes a set of minimum rules governing re-use and the practical arrangements for facilitating re-use of certain information held by public sector bodies, public undertakings, and research data (as long as the applicable conditions are met). This Directive does not apply to documents subject to specific protection, access regimes, or Intellectual Property rights; for this data the Data Governance Act applies. For data obtained with publicly funded research, the Open Data Directive states the principle of “*as open as possible, as closed as necessary*”.

The Open Data Directive enumerates some categories of “high value datasets”, which are: 1. *Geospatial*, 2. *Earth observation and environment*, 3. *Meteorological*, 4. *Statistics*, 5. *Companies and company ownership and 6. Mobility*.

In order to lay down a list of specific high-value datasets and the arrangements for their publication and reuse, the EU Commission adopted the Implementing Act on High-value Datasets Under the Open Data Directive (Regulation (EU) 2023).

The European Strategy for Data is not only focused on adopting new Regulations: as a practical tool to overcome the legal and technical barriers to data sharing in specific sectors, the Strategy envisages the creation of the European Data Spaces. These Data Spaces will be composed of data infrastructures and governance frameworks which will allow data pooling and sharing in strategic sectors. Initially the Commission is planning to create ten Data Spaces (health, industrial & manufacturing, agriculture, finance, mobility, Green Deal, energy, public administration, skills, European Open Science Cloud (EOSC)), but the ultimate goal is to have one common European Data Space, just like there is a single market.

However, the European vision for the Digital Decade goes beyond its Data Strategy. The Digital Decade provides a framework aimed at ensuring “*all aspects of technology and innovation work for people*” (quoting from the EU Commission’s website) with a set of targets, objectives, multi-country projects, and a monitoring mechanism. Underlying this is the European Declaration on Digital Rights and Principles, which states the European values which must be respected in the digital world.

One fundamental aspect in shaping a digital environment fit for the European vision is safety. A safe digital world is not only necessary to guarantee people’s fundamental rights, but it also fosters trust in the new technologies, incentivizing their use. For these reasons another cardinal legislative initiative in the European Union is the

Digital Services Package. In the past few years it has become clear that the objective of building a Europe “*fit for the digital age*”² involves using and exploiting the benefits of new technologies such as Artificial Intelligence. European institutions are thus introducing new legislation to discipline AI so that the EU becomes a world-class hub for these systems and that they are produced and used in a human-centric and trustworthy way.

This has led to the Commission’s proposal for a Regulation on Artificial Intelligence (also known as the “AI Act”) in 2021. During 2023, the European institutions have discussed many aspects of this Act. Partly because of recent significant technological advancements in the field, the original text proposed by the Commission has been significantly revised and updated. Nevertheless, the underlying principles of this Regulation have remained intact: a risk-based approach, which proposes a classification of AI systems on the basis of the risks they pose to individuals and society. The rules stipulated in the AI Act vary according to the risk category in which the Artificial Intelligence systems fall: generally speaking, AI systems posing an unacceptable risk are banned; high-risk systems are subject to a series of conditions before they can be marketable; limited risk AI have some transparency requirements; minimal risk systems have no legal restrictions. Unfortunately, this approach has proved to be unfit for certain new AI systems which have emerged in the past few years and have become popular with non-professional users, such as generative AI. For this reason, EU legislators have inserted in the draft of the AI Act the new categories of “foundation models” and “general purpose AI”, which fall outside the risk-based classification and are subject to specific rules.

At the moment of writing, we are still waiting for the final text of the AI Act, thus many details remain unclear. However, one thing

2. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age_en

certain is that the Act will have to comply with the regulatory ecosystem already in place for the digital world. Therefore, it will not touch aspects already disciplined in other Regulations, like the GDPR for data protection or the Digital Services Act (also known as “DSA”) for safety and fundamental rights protection in the online environment. For example, the DSA contains specific risk assessment obligations for very large online platforms and search engines regarding their algorithmic systems, which will still be applicable when the AI Act becomes effective. In fact, similarly to the AI Act, the DSA also focuses on risks, so it is reasonable to assume that the risk-mitigation measures implemented in compliance with the AI Act must also be relevant for DSA purposes, and vice versa.

In any case, the AI Act will only be fully applicable two years after its entry into force, so we will have to wait to see its rules implemented.

In the meantime, we will have to rely on the other Regulations to ensure a safe and human-centric digital environment envisaged by the European Digital Strategy. The Digital Services Act plays a fundamental role in this field.

Digital Services Act: Shaping the Future of Data Access

The Digital Services Act is one of the two pillars of the European Digital Services Package, together with the Digital Markets Act. The aim of these two Regulations is to create a safer digital environment in which both EU citizens and businesses can thrive. The focus is on tackling the main issues which have arisen in the past years in this field, so everyone can benefit from the new technologies.

While the Digital Markets Act is designed to foster competitiveness, eliminating unfair advantages held by the market “gatekeepers” in this sector, the Digital Services Act contains specific requirements for online platforms and online search engines (especially for the “very large” ones, as we will

see below) in order to create a safe online environment for individuals and companies, in which the fundamental rights guaranteed in the Charter of Fundamental Rights of the European Union are protected.

For researchers the Digital Services Act is of particular interest because of the safeguards it puts in place, especially the data access and scrutiny mechanisms, which give researchers the means to contribute to the objectives of this Regulation.

Generally speaking, the DSA provides a complex framework of obligations and measures regarding transparency, advertising, complaint-handling, protection of minors, online illegal content. It uses a tiered approach and the obligations differ not only on the basis of the service offered (for example: additional provisions are applicable to providers of hosting services) but also on the basis of the dimensions of the intermediary service: providers of “very large online platforms” (also referred to as “VLOPs”) and of “very large online search engines” (also referred to as “VLOSEs”) must comply with a series of further requirements regarding risk assessment and mitigation, crisis response, independent audit, profiling via recommender systems, transparency and, most importantly from our perspective, data access and scrutiny.

These players can have a huge impact on society in terms of security and fundamental rights protection. For example, we have seen how social network profiling can disrupt democracy; how easily online search engines can be used to spread disinformation; the influence that recommender systems can have on minors. For these reasons, it is necessary that VLOPs and VLOSEs be subject to specific risk assessment and mitigation obligations.

Given the purpose of the DSA, which focuses on creating a secure online environment, the systemic risks which must be included in the assessment are:

1. The dissemination of illegal content through their services,

2. Any actual or foreseeable negative effects in relation to:

- fundamental rights, with a focus on the rights to human dignity, respect for private and family life, personal data protection, freedom of expression and information and pluralism of the media, non-discrimination, protection of children and consumers,
- civic discourse and electoral processes, and public security,
- gender-based violence,
- the protection of public health,
- the protection of minors,

3. Serious negative consequences to the person’s physical and mental well-being.

In order to verify VLOPs and VLOSEs compliance with the DSA and the effectiveness of their risk assessment and mitigation operations, the Regulation provides some data access mechanisms. As previously mentioned, this aspect is of particular interest for researchers, who are thus given a pivotal role in ensuring that the objectives of the Digital Services Act are met.

Article 40 of the DSA makes data access possible for researchers in two sets of cases.

The first is reserved to vetted researchers, i.e. researchers who are nominated by the Digital Services Coordinator (of the Member State in which the VLOP’s or VLOSE’s provider is established) after they demonstrate that they meet the following requirements (Art. 40(8) DSA):

- they are affiliated to a research organization;
- they are independent from commercial interests;
- their application discloses the funding of the research;
- they are capable of fulfilling the specific data security and confidentiality requirements corresponding to each request and of protecting
- personal data, and they describe

in their request the appropriate technical and organizational measures that they have put in place to this end;

- their application demonstrates that their access to the data and the time frames requested are necessary for, and proportionate to, the purposes of their research, and that the expected results of that research will contribute to the detection, identification and understanding of systemic risks and to the assessment of the adequacy, efficiency and impacts of the risk mitigation measures adopted by intermediary services;
- the planned research activities will be carried out for the detection, identification and understanding of systemic risks and for the assessment of the adequacy, efficiency and impacts of the risk mitigation measures adopted by intermediary services;
- they have committed themselves to making their research results publicly available free of charge, within a reasonable period after the completion of the research, subject to the rights and interests of the recipients of the service concerned, in accordance with Regulation (EU) 2016.

This data access procedure can be summarized as follows:

1. The researchers apply to the Digital Services Coordinator of an establishment to be granted the status of “vetted researchers” for a specific research project, described in the application, for which they need access to the data of a specific VLOP or VLOSE. The research project must contribute to the detection, identification and understanding of the systemic risks in the Union that the DSA aims to tackle.

2. If the Digital Services Coordinator approves the researchers’ request, it will transmit a reasoned request to the relevant VLOP’s or VLOSE’s provider. The procedure

could stop here, with the provider granting access to its data to the vetted researchers as requested.

3. The provider could also ask the Digital Services Coordinator to amend its request if the provider considers itself unable to give access to the data required for one of the following reasons: it doesn't have access to the data, or giving access to the data would lead to significant vulnerabilities in the security of its service or the protection of confidential information, in particular trade secrets. The request for amendment should contain proposals for one or more alternative means to provide access to the requested data or other data which are appropriate and sufficient for the purpose of the researchers' request.

4. The Digital Services Coordinator decides whether to amend its request or reject the

provider's instance.

In these cases, the provider will have to facilitate and provide access to its data through appropriate interfaces specified in the researchers' request, including online databases or application programming interfaces.

On the other hand, Art. 40(12) of the DSA creates an obligation for the providers to give access to their data to researchers when all the following conditions are met:

- The data is publicly accessible through their interfaces (so this provision does not apply to all the VLOPs' and VLOSEs' data);
- The researchers, though they do not need to be designated "vetted researchers", comply with the conditions set out in Art. 40(8) points (b), (c), (d) and (e) of the DSA (see above);

- The researchers use the data solely for performing research that contributes to the detection, identification and understanding of systemic risks in the European Union.

The DSA does not give further indications about the practical means to access the providers' data, what kind of data should be subject to these provisions and the purposes of their processing, or the procedures for Digital Services Coordinators to manage the requests and vet the researchers. These issues should be addressed by delegated acts adopted by the European Commission. At the time of writing, Commission adoption of the delegated acts is planned for the first quarter of 2024.

Contact: Roberto Trasarti, KDDLab
roberto.trasarti@isti.cnr.it

AI-SAFETY

AI-based Smart System for Operator Safety in Manufacturing Processes Funded by INAIL Grant BRiC 2022

In the industrial realm, it is well known that many accidents involving machine operators in production processes are in some way linked to the operator's behavior and to particular types of errors. No matter how sophisticated, traditional control and supervision systems have been unable to entirely eliminate or satisfactorily manage these risks. This issue becomes particularly acute when machines malfunction, such as with product jams that need to be cleared or with other breakdowns that require operators to access dangerous areas of the machine and intervene actively.

Predicting operational conditions linked to faults, malfunctions, and operator errors is challenging during the design phase. The necessary interventions may not be easily definable and this can lead to accidents or

near-miss incidents. In this context, equipping machines with networks of sensors and Artificial Intelligence (AI) systems capable of interpreting new operational situations, of recognizing potential risk conditions for operators, and of generating appropriate commands is seen as an effective path towards enhancing user safety.

AI-SAFETY steps into this challenging scenario with a groundbreaking approach. By integrating AI with Radio Frequency Identification (RFID) technology, and a network of intelligent cameras, it offers a proactive solution to enhance workplace safety. The system's AI brain analyzes data from the cameras and RFID tags worn by operators, understanding the workspace dynamics in real-time. If any risks are detected, it can instantly instruct the machines to stop or

adjust operation, often before human reaction is possible.

Moreover, AI-SAFETY respects the indispensable role of human judgment. Supervisors monitor the system, ensuring that the balance between automated safety measures and human oversight is maintained. Compliant with strict safety and data protection regulations, AI-SAFETY is not just about employing advanced technology; it is about responsibly creating a safer industrial environment in which technology and human expertise collaborate to prevent accidents.

Contact Information:
Claudio Gennaro, AIMH Lab
claudio.gennaro@isti.cnr.it



TANGO

It Take Two to TANGO: a Synergistic Approach to Human-Machine Decision Making Funded by Horizon Europe

Artificial Intelligence (AI) holds tremendous potential to enhance human decisions and to avoid cognitive overload and bias in high-stakes scenarios. To date, however, the adoption of AI-based support systems has been minimal in settings such as hospitals, tribunals and public administrations.

The TANGO project tackles these challenges, by developing the theoretical foundations and the computational framework for synergistic human-machine decision making, paving the way for the next generation of human-centric AI systems. A new EU-funded project, starting in September 2023, with 21 partner organisations from 9 countries across Europe, is set to strengthen the leadership of Europe in this area.

TANGO argues that to fully develop their

enormous potential in terms of positive impact on individuals, society and economy, we need to completely rethink the way in which AI systems are conceived. People should feel they can trust the systems with which they interact in terms of reliability of predictions and decisions, of capacity to understand needs, and of guarantees that the systems are genuinely aiming at supporting them rather than some undisclosed third party. In other words, a symbiosis should be established between humans and machines, in which all parties are aligned in terms of values, goals and beliefs, thus achieving objectives beyond those which would be separately possible.

The potential impact on individuals and society of the TANGO framework will be evaluated on a pool of real-world use cas-

es of extremely high social impact, namely supporting women during pregnancy and postpartum, supporting surgical teams in intraoperative decision making, supporting loan officers and applicants in credit lending decision processes, and helping public policy makers in designing incentives and allocating funds. The success of these case studies will foster the adoption of TANGO as the framework of reference for developing a new generation of synergistic AI systems, and will strengthen the leadership of Europe in human-centric AI.

Contact:

Salvatore Rinzivillo, KDD Lab

salvatore.rinzivillo@isti.cnr.it



TANGO

PRIN 2022 – PRIN 2022 PNRR

Funded by MUR

The PRIN program (Progetti di ricerca di Rilevante Interesse Nazionale – Research Projects of National Importance) published by the Italian Ministry for the Universities and Research (MUR) is designed to fund public research projects aimed at strengthening the national scientific foundations, in particular in preparation for more effective participation in European Union Framework Programs. The program finances proposals from individual or multiple researchers/institutions.

The guiding principles of the PRIN program are the scientific expertise of the Principal Investigator (PI) and unit leaders, plus the originality, methodological appropriateness, impact, and feasibility of the research project proposed.

In 2022, MUR released two calls: PRIN 2022 and PRIN PNRR 2022. The results of these calls were announced at the end of 2023, with notable success for researchers at ISTI: 13 proposals under PRIN 2022 and 7 proposals under PRIN PNRR 2022 were selected and guaranteed funding.

Here below, a brief overview of the successful proposals.

PRIN 2022

The ATLAS of Italian Digital Humanities: a dynamic knowledge graph of digital scholarly research on Italian Cultural Heritage (ATLAS-AIDH)

Ref. Alessia Bardi

The ATLAS project fosters FAIRness (Findability, Accessibility, Interoperability, Reusability) and exploitation of Digital Humanities scholarly data on Italian Cultural Heritage. ATLAS will create a knowledge graph by collecting and enriching information extracted from online resources produced in the international academic context,

such as digital textual corpora and datasets following Linked Open Data principles, databases, ontologies and community-adopted tools. ATLAS leverages existing digital heritage resources to develop an innovative system which reuses scholarly projects in new non-native environments. (<https://dh-atlas.github.io/>)

Italian Performance Archive in Digital (I_PAD)

Ref. Massimo Magrini

This project introduces an innovative framework and a storage system in the form of an open-access online repository. The repository is designed to house and showcase theater productions that incorporate technological components.

The case study consists of the Giacomo Verdi Archive, which is representative of the Italian Video Theatre Movement (1980-1995); scholars from 2 Universities (University of Milan and the Link Campus University of Rome) and from ISTI-CNR are involved in phases of the work: selection, digitization, archiving, metadating, re-enactment. Primary goals are to identify a cataloguing methodology, a taxonomy for organizing findings and relative protocols, and appropriate digitization models in consideration of the inherent complexity of video works.

Open AI solutions for Historical Masonry Annotation (OPUS)

Ref. Marco Callieri

The project will apply AI-powered tools in the study of historical masonry. The study of historical masonries in the Cultural Heritage field is a challenging task with implications for different disciplinary fields, from the acquisition of historical-artistic knowledge, to the practical conservation of ancient buildings.

The OPUS project will develop AI tools

based on the human-in-the-loop paradigm, exploiting the knowledge and expertise of professionals and assisting their everyday work.

Science, Technology, Engineering and Math Motivation & Accessibility (STEMMA)

Ref. Barbara Leporini

The STEMMA project aims (1) to investigate the main difficulties and barriers to accessibility to STEM curricula and careers experienced both by women and by people with visual impairments, and (2) to propose digital resources, tools and good practices to motivate, increase interest and enhance education in these disciplines regardless of gender and disability.

Urban Artificial Intelligence (URBAI)

Ref. Luca Pappalardo

URBAI aims to study the impact of human mobility on urban well-being and design next-generation AI tools that allow this impact to be controlled and to benefit from it. The project focusses on navigation systems (NS, such as Google Maps) and public mobility services (MS, e.g., ride-hailing companies like Uber). The URBAI project has three aims:

1. to design indicators to measure urban well-being for environmental quality, security and socio-economic segregation;
2. to study the impact of NS and MS on urban well-being using mobility data and simulation frameworks;
3. to design and validate next-generation AI assistants that control the impact of human mobility and benefit from it.

Audiometry by PUPIL Response (APURE)

Ref. Antonino Crivello

The measurement of cognitive resource allocation during audio perception, or delivery

of listening efforts, provides valuable insight into the factors influencing auditory processing.

In APURE, we propose the use of the pupillary dilation response (PDR), a short-latency component of the response evoked by novel stimuli, as an indicator of sound detection. PDR can be considered a physiological signal and requires no voluntary effort. The main purpose of this project is to transform the audiometric test from a subjective to an objective examination.

End-User Development for eXtended Reality (EUD4XR)

Ref. Marco Manca

Today's eXtended Reality (XR) technologies are quite mature and affordable. However, a key to their adoption is to support end-users in autonomous content creation and enable them to 'program' the intended behaviour. EUDeVs (End Users Developers) will start from pre-defined XR elements, and will compose and configure the interaction of elements with users or other objects through the definition of rules that are readable as natural language sentences. The resulting system will be validated in three application domains (virtual museum, smart home and training).

Conversational Agents: Mastering, Evaluating, Optimizing (CAMEO)

Ref. Raffaele Perego

CAMEO aims at enhancing conversational agents through the innovative use of user contextual information, including information collected during past interactions of the user with the system.

This contextual information, enriched with external knowledge from the application domain considered, is exploited to extract insights enabling a rich and satisfying user interaction through advanced dialogue management, query answering, personalized search, and recommendation.

Artificial Intelligence with Cultured Neuronal Networks (AICult)

Ref. Giuseppe Amato

The aim of this project is to investigate and develop solutions to use Cultured Neuronal Networks (CultNN), i.e. biological cultures of actual neuronal cells, in Artificial Intelligence. We will investigate training methods, learning optimized solutions for engineering and interacting with CultNN. We propose a radical paradigm shift for AI, based on the direct use of CultNN, rather than bioinspired Artificial Neural Networks. We aim at designing devices based on actual biological cultures of neuronal cells capable of learning and performing AI tasks. The final product of our research will be a "biological" AI co-processor that can perform AI tasks.

Word EMBeddings: From Cognitive Linguistics to Language Engineering, and Back (WEMB)

Ref. Alejandro Moreo, Fabrizio Sebastiani

At the heart of the deep-learning approach to the semantics of text (and to lexical semantics in particular) lies the concept of word embedding, a dense vectorial representation of a word's meaning lying in a vector space in which the semantic similarity of words is embodied in the notion of distance between vectors. While current-generation word embeddings have proven to be a useful engineering method for modelling word meaning and have brought about impressive accuracy improvements in NLP / text mining tasks, it remains unclear to what extent they reflect the organization of word meaning in the human mind, and therefore to what extent they can inform us on human language processing.

The goal of the WEMB project is twofold, i.e.,

1. to achieve a better understanding of how word embeddings relate to language processing in the human mind
2. to use this understanding to contribute to the development of a new generation of word embeddings that can be applied to NLP / text mining tasks.

Enhancing Underwater PHotogrammetry, fluOreScence imagerY and deep learning solutions for monitoring the health status of mediterranean corals (EUPHROSYNE)

Ref. Gaia Pavoni

The main goal of EUPHROSYNE is to improve a multi-sensor measuring system based on the integration of photogrammetry and fluorescence imagery, and to test and validate this system both in the laboratory and in open water. The project also includes the development of AI, computer vision and geometrical processing algorithms for the automatic assessment of species health status using fluorescence, and to evaluate data salient measures (e.g. surface area/volume of polyps) on a large scale.

REFlectance EXploration: improving the acquisition, distribution, and exploration of multi-light image collections for surface characterization and analysis (REFLEX)

Ref. Federico Ponchio

The REFlectance EXploration research project aims to improve the entire workflow of Reflection Transformation Imaging (RTI) data, also known as multi-light image collections (MLIC). It would cover the entire pipeline, from MLIC acquisition (sets of photographs captured with a fixed camera but variable illumination) up to surface characterization and analysis.

The project aims to establish a unique framework to store and manage the data and metadata for various lighting setups. This framework will streamline the capture of rich Multimodal Live Interactive Content (MLIC) by offering simplified setup and calibration processes.

Innovative algorithms will be developed to decouple shape from reflectance, providing compressed representations of geometric and material features, and exploiting data-driven AI-based methods. An implementation of these algorithms will

be made available as an open-source library for customized capture, processing, and exploration in the cultural heritage and industry 4.0 domains.

Spatio-Temporal Enhancement of Neural nets for Deeply Hierarchical Automatised Logic (STENDHAL)

Ref. Vincenzo Ciancia

The main objective of STENDHAL is to advance the theory and implementation of spatial logics towards multimodal reasoning, and in particular spatio-temporal and multiscale/hierarchical reasoning, and towards hybridization with state-of-the-art neural networks. The approach will be validated on medical imaging case studies (glioblastoma segmentation, ASPECT score, cortical thickness estimation) and on case studies related to the modelling of cyber-physical systems.

PRIN 2022 PNRR

End-User Development of Automations for Explainable Green Smart Homes

Ref. Fabio Paternò

The goal of the project is to design and develop a multimodal app integrating chatbot and augmented reality features with intelligent recommendations for end-user automation specification and control. This app will be part of a digital twin of the Green Smart Home, contributing functionality for simulating and analysing the possible effects of the automations. The user experience with the resulting Green Smart Home and its components will also be investigated through laboratory studies and deployment in real homes to study its impact and adoption in daily life.

Quantification in the Context of Dataset Shift (QuaDash)

Ref. Alejandro Moreo, Fabrizio Sebastiani

The QuaDaSh project aims to advance research in quantification, which involves predicting the prevalence of different classes in a new dataset. As example, consider a

scenario in which we want to determine the percentage of positive, neutral, and negative opinions in tweets related to a specific hashtag. Traditional quantification approaches typically rely on a dataset with pre-labeled opinions on the same topic to train a model that predicts class prevalence.

In our project, we go beyond the conventional focus on prior probability shift (which deals with variations in class proportions) and consider broader challenges associated with dataset shift (scenarios where the training dataset may also exhibit variations in other aspects). For example, the training set might be in a different language or consist of labelled opinions about a different topic, introducing what is known as covariate shift.

By addressing these broader challenges, QuaDaSh aims to devise improved solutions for real applications of quantification that may encounter diverse types of dataset shift. Examples of these include seabed cover mapping, small area estimation, or fairness auditing, to name a few.

Reconstructing Fragmentary Papyri through Human-Machine Interaction

Ref. Fabrizio Falchi

The project investigates the application of Artificial Intelligence to the reconstruction of specific lots of papyrus fragments from two Italian papyrological collections: the Papyri collection of the Società Italiana, stored at the Istituto Papirologico "G. Vitelli" (University of Florence), and the Papyri collection of the University of Genova.

Following an innovative and interdisciplinary approach, the two university teams will work closely with ISTI to implement an already prototyped interactive software aimed at assisting papyrologists in the screening phase and, mainly, in the matching of fragments, allowing the user to evaluate and revise multiple reconstruction hypotheses. The system will take advantage of visual information from both the front and the back of the fragments by exploiting the continuity of the fiber patterns and by taking into ac-

count positional information and additional constraints supplied by experts.

ADVancEd iNtegraTed valUation of Railway systemS (ADVENTURE)

Ref. Maurice ter Beek

ADVENTURE will develop innovative solutions to evaluate modern railway systems, focusing on:

1. qualitative evaluation of safety of complex distributed railway systems;
2. quantitative evaluation of dependability attributes in spite of failures;
3. quantitative evaluation of trade-offs between energy efficiency and availability/performance.

The developed solutions will be validated by applying them to representative railway systems.

A MULTimedia platform for Content Enrichment and Search in audiovisual archives (MUCES)

Ref. Fabio Carrara

The project aims to develop advanced visual analysis and retrieval methodologies that can make unlabeled Italian audiovisual archives searchable through natural language and exemplar queries in a personalized manner. The methodologies will be multi-modal, adaptable to long-tail concepts, and efficient for large-scale archives. The project aims to bridge cutting-edge research in Computer Vision and Content-based Image Retrieval to enhance the accessibility of audiovisual Cultural Heritage in Italy.

Empowering Knowledge Extraction to Empower Learners (EKEEL)

Ref. Claudio Gennaro

The EKEEL project is dedicated to the extraction of knowledge from educational videos, specifically aiming to identify and analyze key concepts presented and the interdependencies between them.

A significant aspect of this analysis is the identification of prerequisite relations (PR), which are crucial in determining the foundational knowledge necessary to comprehend a given concept. This focus on PRs assists the understanding of the sequential and hierarchical structure of the concepts explained within the educational material.

The project aspires to bolster autonomous learning and enhance the digital education landscape by leveraging a distinctive audio-visual method and aligning with the Digital Education Action Plan 2021-27.

A Data-driven Investigation into the Cognitive Demands of Reading Braille (BRAILLET)

Ref. Barbara Leporini

The importance of Braille literacy is widely acknowledged.

In contrast to auditory methods, Braille reading has been shown to enhance attention deployment, improve comprehension, reduce mind wandering, and correlate with higher educational, employment, and economic achievements. However, despite progress in understanding the similarities and differences between print and Braille reading, a comprehensive understanding of how motor and cognitive factors impact Braille reading, along with potential learning challenges, still needs to be achieved.

Many scientific studies have focused on small samples of blind individuals, often relying on single-case studies. There is a critical need for large-scale reading data, possibly longitudinal, to advance our knowledge in this area.

In this context, the BRAILLET project aims to develop an innovative prototype platform

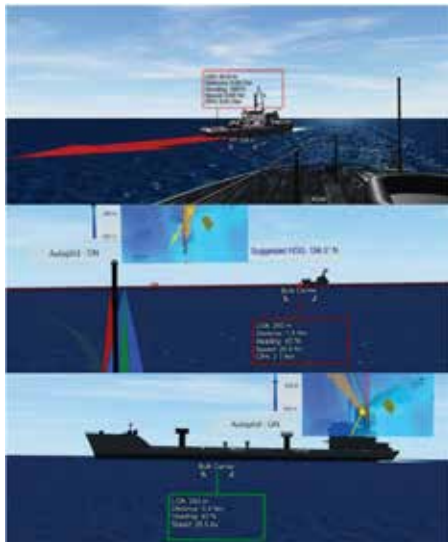
using cutting-edge Information and Communication Technology (ICT) and Natural Language Processing (NLP) solutions. The platform is designed to automatically gather, time-align, analyze, and categorize the fine-grained finger movements and digitized speech productions of adult individuals, both blind and sighted, engaged in reading tasks.

The time-aligned data acquired will serve various purposes, including building an open-access, multimodal repository of Italian Braille and print reading data, developing automatic classifiers and quantitative models of Braille reading strategies, comparing these models with print reading models, assessing optimal text layouts for blind readers, and providing the blind community with a prototype screening tool to monitor the longitudinal progress of individuals learning Braille.

E-Navigation: a Distributed Decision Support System with Extended Reality for Bridge and Ashore Seafarers

P. Cassarà, M. Di Summa, A. Gotta, M. Martelli

IEEE Transactions on Intelligent Transportation Systems, vol. 24. IEEE, 2023.



Viewer functionalities.

A distributed decision support system has been developed to assist seafarers during several navigation tasks, for instance, in avoiding a collision with a detected obstacle in the sea and envisioning a future autonomous navigation system. In this paper, the decision support system is based on the results of a customized simulation model representing the ship's behavior, including hydrodynamics, propulsion, and control effects. Sensors monitor and collect the parameters of the environment and the ship onboard. The telemetry and the calculated route are visualized on a wearable visor exploiting augmented reality. Such context information is also replicated ashore through a narrow-band satellite link using an IoT

publish-subscribe communication paradigm to allow one or more remote seafarers to supervise the situation in a virtual reality environment. Overall, the potential of the proposed system is presented and discussed for application in the context of autonomous navigation.

DOI: 10.1109/TITS.2023.3311817

A Bluetooth 5.1 Dataset Based on Angle of Arrival and RSS for Indoor Localization

M. Girolami, F. Furfari, P. Barsocchi, F. Mavilia

IEEE Access, vol. 11. IEEE, 2023.

Several Radio-Frequency technologies have been explored to evaluate the efficacy of localization algorithms in indoor environments, including Received Signal Strength (RSS), Time of Flight (ToF), and Angle of Arrival (AoA). Among these, AoA technique has been gaining interest when adopted with the Bluetooth protocol. In this work, we describe a data collection measurement campaign of AoA and RSS values collected from Bluetooth 5.1 compliant tags and a set of anchor nodes deployed in the environment. We detail the adopted methodology to collect the dataset and we report all the technical details to reproduce the data collection



The adopted hardware for the data collection. Anchor nodes are mounted on top of a tripod with a professional head enabling an accurate orientation

process. The resulting dataset and the adopted software is publicly available to the community. To collect the dataset, we deploy four anchor nodes and four Bluetooth tags and we reproduce some representative

scenarios for indoor localization: calibration, static, mobility, and proximity. Each scenario is annotated with an accurate ground truth (GT). We also assess the quality of the collected data. Specifically, we compute the Mean Absolute Error (MAE) between the AoA estimated by the anchors and the corresponding GT. Additionally, we investigate the packet loss metric which measures the percentage of Bluetooth beacons lost by the anchors.

DOI: 10.1109/ACCESS.2023.3301126

A Toolchain for Strategy Synthesis with Spatial Properties

D. Basile, M.H. ter Beek, L. Bussi, V. Ciancia

International Journal on Software Tools for Technology Transfer, vol. 25. Springer, 2023.

We present an application of strategy synthesis to enforce spatial properties. This is achieved by implementing a toolchain that enables the tools CATLib and VoxLogicA, both developed at CNR-ISTI, to interact in a fully automated way. The Contract Automata Library (CATLib) is aimed at both composition and strategy synthesis of games modelled in a dialect of finite state automata. The Voxel-based Logical Analyser (VoxLogicA) is a spatial model checker for the verification of properties expressed using the Spatial Logic of Closure Spaces on pixels of digital images.

Strategy synthesis concerns the automatic computation of a (safe, optimal) strategy (controller) in a game-based automata setting. In such a setting, a strategy is a prescription of the behaviour (transitions) of a particular player for all possible situations (states) that leads that player to a specific goal (final state). Typically, there are other

players or an environment with different, often competing goals to account for, and the set of transitions may be partitioned into controllable (by the particular player) and uncontrollable transitions.

Spatial properties (of points in graphs, digital images, or 3D meshes and geometric structures) are related to topological aspects, like being near to points satisfying a given property, or being able to reach a point satisfying a certain property, passing only through points obeying specific constraints. Recent advancements in spatial model checking have led to relevant results like the fully automated segmentation of regions of interest in medical images by brief, unambiguous specifications in spatial logic.

We provide examples of strategy synthesis on automata encoding motion of agents in spaces represented by images, as well as a proof-of-concept realistic example based

on a case study from the railway domain. The strategies are synthesised with CATLib, while the properties to enforce are defined by means of spatial model checking of the images with VoxLogicA. The combination of spatial model checking with strategy synthesis provides a toolchain for checking and enforcing mobility properties in multi-agent systems in which location plays an important role, like in many collective adaptive systems. We discuss the toolchain's performance also considering several recent improvements.

DOI: [10.1007/s10009-023-00730-1](https://doi.org/10.1007/s10009-023-00730-1)



A scenario where one train is waiting to enter a junction area while another train is traversing it (leftmost) and (second from left to right) the initial configuration of the railway example, a final configuration in which both trains exit the junction from the same route, and the junction area emphasised in purple.

DAEMON: a Domain-Based Monitoring Ontology for IoT Systems

S. Daoudagh, E. Marchetti, A. Calabrò, F. Ferrada, A.I. Oliveira, J. Barata, R. Peres, F. Marques
SN Computer Science , vol. 4. Springer, 2023.

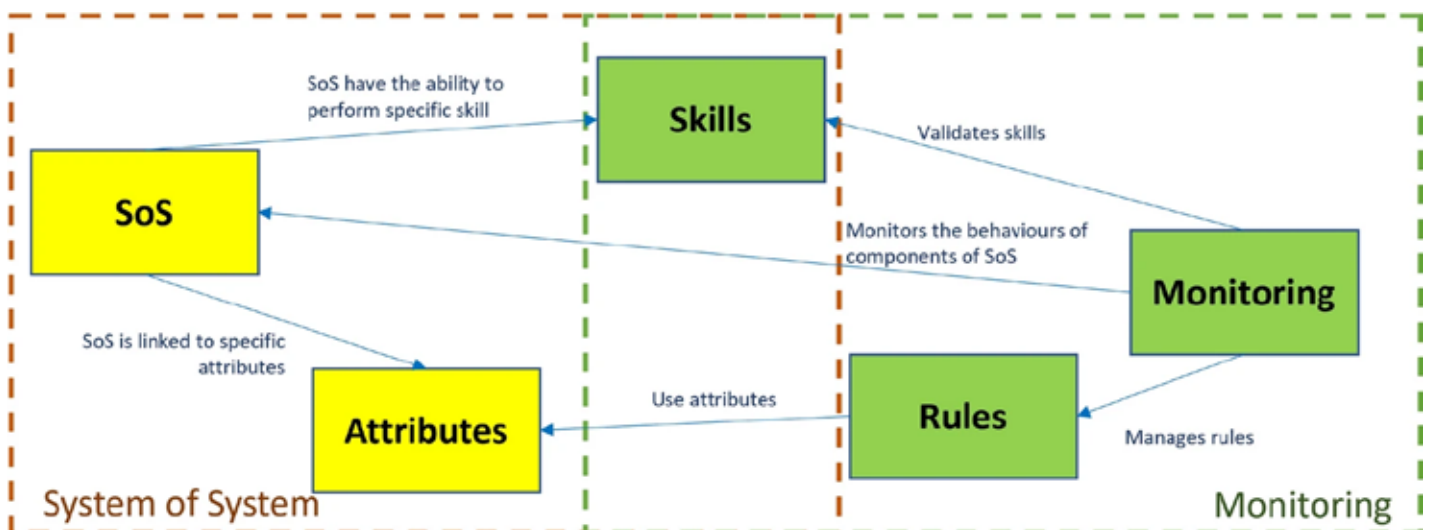
Quality, trustworthiness, and cybersecurity are essential attributes of Internet of Things (IoT) systems and ecosystems. However, even if an important industrial and academic research activity is devoted to conceiving and implementing solutions able to guarantee, monitor, and assess these attributes during the overall development process, the time-to-market, the productivity, and the competitiveness impose quick releasing deadlines that may decrease the general quality level and increase the number of possible vulnerabilities and weaknesses. Therefore, in line with the development life-cycle, practical, integrated methodologies, and mechanisms for leveraging the understanding and management of the functional and non-functional quality attributes, evaluating the development risks, and reducing the vulnerability threats are necessary.

A commonly applied solution for satisfying these needs is using a monitoring sys-

tem that enables the analysis of functional and non-functional properties during the IoT execution. Indeed, thanks to the analysis of the events produced by the systems, devices, or components during their on-line use, an assessment of specific properties can be performed. Additionally, the monitoring system promptly raises alarms or implements countermeasures in case of abnormal behavior detection. Despite the exposed efficacy, the main objection against adopting the monitoring system is the costs (in terms of effort and time) related to its design, implementation, and management. Indeed, monitoring activity needs to be integrated into the stages of the software development process and involves several stakeholders, such as IoT domain experts, developers, or monitoring experts. Thus, this article presents the methodology and architecture of the Domain bAsEd Monitoring ONtology (DAEMON) framework useful for realizing a manageable and user-friendly

integrated monitoring system. DAEMON, integrates concepts and definitions about the IoT and monitoring into a unique manageable ontology-based representation. In particular. Though its reference architecture and its GUI, components' interaction, and roles it, DAEMON provides a domain-based ontology that formally models monitoring, IoT, and System of Systems (SoS) domains' knowledge. Validation of DAEMON into a multi-robot autonomous navigation scenario applied to the intralogistics domain is presented.

DOI: 10.1007/s42979-023-01975-y



DAEMON Ontology modules

Model-Based Security Testing in IoT Systems: a Rapid Review

F. Lonetti, A. Bertolino, F. Di Giandomenico

Information and Software Technology, vol. 164. Elsevier, 2023.

Context: Security testing is a challenging and effort-demanding task in IoT scenarios. The heterogeneous devices expose different vulnerabilities that can influence the methods and cost of security testing. Model-based security testing techniques support the systematic generation of test cases for the assessment of security requirements by leveraging the specifications of the IoT system model and of the attack templates.

Objective: This paper aims to review the adoption of model-based security testing in the context of IoT, and then provides the first systematic and up-to-date comprehensive classification and analysis of research studies in this topic.

Method: We conducted a systematic literature review analysing 803 publications and finally selecting 17 primary

studies, which satisfied our inclusion criteria and were classified according to a set of relevant analysis dimensions.

Results: We report the state-of-the-art about the used formalisms, the test techniques, the objectives, the target applications and domains; we also identify the targeted security attacks, and discuss the challenges, gaps and future research directions.

Conclusion: Our review represents the first attempt to systematically analyze and classify existing studies on model-based security testing for IoT. According to the results, model-based security testing has been applied in core IoT domains. Models complexity and the need of modeling evolving scenarios that include heterogeneous open software and hardware components remain the most important shortcomings.

Our study shows that model-based security testing of IoT applications is a promising research direction. The principal future research directions deal with: extending the existing modeling formalisms in order to capture all peculiarities and constraints of complex and large scale IoT networks; the definition of context-aware and dynamic evolution modelling approaches of IoT entities; and the combination of model-based testing techniques with other security test strategies such as penetration testing or learning techniques for model inference.

DOI: 10.1016/j.infsof.2023.107326

Table 6: Primary Studies *vs* Attacks

Ref#	Denial of Service (DoS)	Dictionary	Injection	Brute Force	Eavesdropping	Tampering	Data Leakage	Key Logger	Social Engineering
[11]					✓				
[65]		✓		✓				✓	✓
[66]		✓		✓				✓	✓
[35]		✓		✓				✓	✓
[31]	✓			✓					
[67]	✓				✓				
[37]					✓	✓			
[68]	✓								
[69]	✓								
[70]	✓	✓							
[71]							✓		
[72]			✓		✓				
[73]									
[74]	✓								
[40]									
[26]	✓		✓						
[41]	✓		✓		✓	✓	✓		

SAL τ : Efficiently Stopping TAR by Improving Priors Estimates

A. Molinari, A. Esuli

Data Mining and Knowledge Discovery, in press. Springer, 2023.

In high recall retrieval tasks, human experts review a large pool of documents with the goal of satisfying an information need. Documents are prioritized for review through an active learning policy, and the process is usually referred to as Technology-Assisted Review (TAR). TAR tasks also aim to stop the review process once the target recall is

achieved to minimize the annotation cost. In this paper, we introduce a new stopping rule called SAL τ (SLD for Active Learning), a modified version of the Saerens–Latinne–Decaestecker algorithm (SLD) that has been adapted for use in active learning. Experiments show that our algorithm stops the review well ahead of the current state-of-

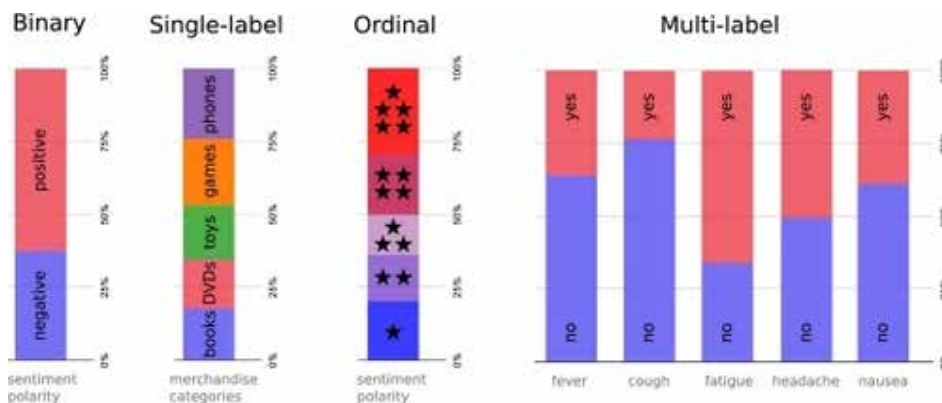
the-art methods, while providing the same guarantees of achieving the target recall.

DOI: 10.1007/s10618-023-00961-5

Multi-Label Quantification

A. Moreo, M. Francisco, F. Sebastiani

ACM Transactions on Knowledge Discovery in Data, vol. 18. ACM, 2023.



Different types of quantification problems. From left to right: binary quantification (e.g., estimating the prevalence values of positive reviews and negatives reviews in a set of product reviews), single-label quantification (e.g., estimating the prevalence values of different merchandise classes in a set of product reviews), ordinal quantification (e.g., estimating how a set of reviews of a certain product distributes across different “star” ratings), and MLQ (e.g., estimating the prevalence values of different, non mutually exclusive symptoms in a set of patients).

Quantification, variously called supervised prevalence estimation or learning to quantify, is the supervised learning task of generating predictors of the relative frequencies (a.k.a. prevalence values) of the classes of interest in unlabelled data samples. While

many quantification methods have been proposed in the past for binary problems and, to a lesser extent, single-label multi-class problems, the multi-label setting (i.e., the scenario in which the classes of interest are not mutually exclusive) remains by

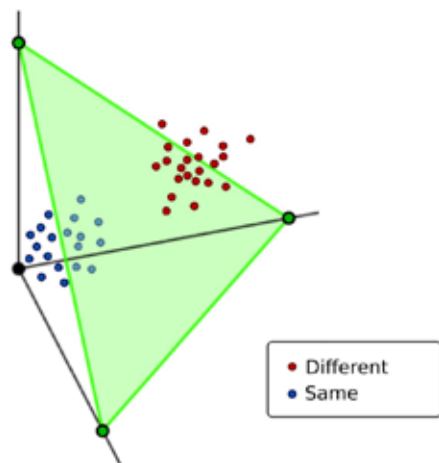
and large unexplored. A straightforward solution to the multi-label quantification problem could simply consist of recasting the problem as a set of independent binary quantification problems. Such a solution is simple but naïve, since the independence assumption upon which it rests is, in most cases, not satisfied. In these cases, knowing the relative frequency of one class could be of help in determining the prevalence of other related classes. We propose the first truly multi-label quantification methods, i.e., methods for inferring estimators of class prevalence values that strive to leverage the stochastic dependencies among the classes of interest in order to predict their relative frequencies more accurately. We show empirical evidence that natively multi-label solutions outperform the naïve approaches by a large margin. The code to reproduce all our experiments is available online.

DOI: 10.1145/3606264

Same or Different? Diff-Vectors for Authorship Analysis

S. Corbara, A. Moreo, F. Sebastiani

ACM Transactions on Knowledge Discovery in Data, vol. 18. ACM, 2023.



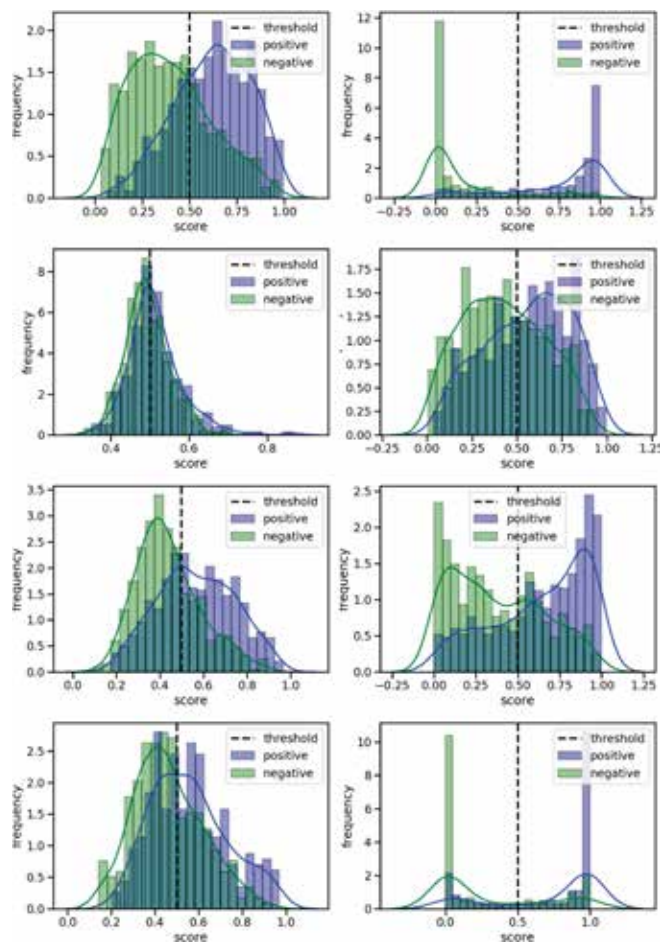
3-dimensional example of the surface (in green) that (ideally) separates the region of DVs belonging to Same (which corresponds to the tetrahedron comprised between the separating surface and the origin of the axes) and the region of DVs belonging to Different, in the linear case. When the number of features is t , the tetrahedron becomes a t -simplex and the separating surface is a $(t - 1)$ -simplex.

In this article, we investigate the effects on authorship identification tasks (including authorship verification, closed-set authorship attribution, and closed-set and open-set same-author verification) of a fundamental shift in how to conceive the vectorial representations of documents that are given as input to a supervised learner. In “classic” authorship analysis, a feature vector represents a document, the value of a feature represents (an increasing function of) the relative frequency of the feature in the document, and the class label represents the author of the document. We instead investigate the situation in which a feature vector represents an unordered pair of documents, the value of a feature represents the absolute difference in the relative frequencies (or increasing functions thereof) of the feature in the two documents, and the class label indicates whether the two documents

are from the same author or not. This latter (learner-independent) type of representation has been occasionally used before, but has never been studied systematically. We argue that it is advantageous, and that, in some cases (e.g., authorship verification), it provides a much larger quantity of information to the training process than the standard representation. The experiments that we carry out on several publicly available datasets (among which one that we here make available for the first time) show that feature vectors representing pairs of documents (that we here call Diff-Vectors) bring about systematic improvements in the ef-

fectiveness of authorship identification tasks, and especially so when training data are scarce (as it is often the case in real-life authorship identification scenarios). Our experiments tackle same-author verification, authorship verification, and closed-set authorship attribution; while DVs are naturally geared for solving the 1st, we also provide two novel methods for solving the 2nd and 3rd that use a solver for the 1st as a building block. The code to reproduce our experiments is open-source and available online.

DOI: 10.1145/3609226



Distribution of $\Pr(\text{Same}|x', x'')$ values for Same and Different pairs as computed by STD-DistCos (first column) and DV-Bin (second column).

Older Adults' User Experience with Introvert and Extravert Humanoid Robot Personalities

E. Zedda, M. Manca, F. Paternò, C. Santoro

Universal Access in the Information Society, early view. Springer, 2023.

Humanoid robots can be an effective tool for the cognitive training of older adults. For this purpose, it is important that their interaction be engaging. In this study, we investigate whether proposing robots exhibiting extraverted or introverted personalities can improve user experience. In particular, we have designed and implemented a set of multi-modal cues for such personality traits, which have been exploited in an application

proposing typical exercises for cognitive training through a Pepper robot. We report on a user test with 24 older adults (65+), which provided interesting and positive feedback regarding how the robot personalities have been exhibited and their impact on the experience of such users.

DOI: 10.1007/s10209-023-01054-2



Animations example for introvert personality (upper image), for extravert personality (lower image).

A Mobile Augmented Reality App for Creating, Controlling, Recommending Automations in Smart Homes

A. Mattioli, F. Paternò,

Proceedings of the ACM on Human-Computer Interaction, vol. 7. ACM, 2023.



(Left) after configuring the trigger “Entrance door”, a recommendation is placed over the Entrance light; (centre) a schematic view of the rule currently in editing; (right) the “Explore environment” modality displays the created automations over the associated virtual objects.

Automations in the context of smart homes have been adopted more and more frequently; thus, users should be able to con-

trol them and create automations most suitable to their needs. Current solutions for this purpose are based on visual apps with

conceptual representations of possible automation elements. However, they tend to be static, abstract, and detached from the user's real context. In this paper, we propose a novel solution based on mobile augmented reality, which provides situated, dynamic representations associated with the physical objects available in the current users' context while they are freely moving about. It allows direct interaction with the objects of interest, monitoring nearby objects' automations while moving, and creating new automations or modifying existing ones. It also supports users with recommendations of object and service configurations relevant to complete the editing of the new automations. The paper also reports on a user test, which provided positive feedback.

DOI: 10.1145/3604242

A Serious Web Game for Children with Attentive Disorders: Design and Experiences from Two Trials

L. Angileri, M. Manca, F. Paternò, C. Santoro
Human-Computer Interaction. Taylor&Francis, 2023.

Cognitive developmental disorders are common in children and can affect various abilities. Attention Deficit/Hyperactivity Disorder (ADHD) is the most prevalent childhood psychiatric condition. This work presents PlayToPickUp, a serious game that aims to stimulate children in relevant cognitive domains (attention and error monitoring). A multidisciplinary team of experts and caregivers from two different centers that support therapeutic activities with such children participated from the game's inception to the design and the evaluation of the game. Depending on the characteristics and abilities of the player, therapists can



The first level of the PlayToPickUp game.

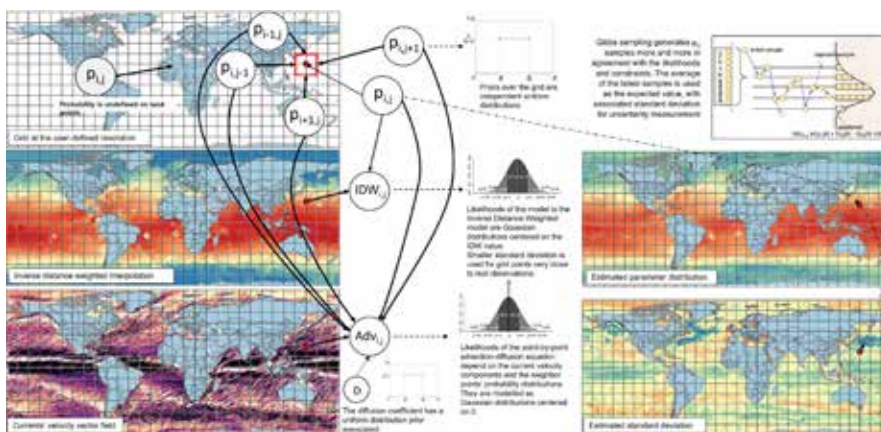
customize the game to provide training that best fits the skills and the needs of the child while maintaining the player's motivation. After its development, the game was used

over 2 months "in the wild" by children recruited by the two centers. In one case the children played with it within the regular activities offered by the training center. In the other one, the parents of the children were instructed by caregivers to have the children play the game at home. In the paper, we describe the experience gathered from such two studies run in parallel, discussing the aspects that worked better, those that represented difficulties, and the lesson learnt for future studies.

DOI: 10.1080/07370024.2023.2240797

An Open Science Oriented Bayesian Interpolation Model for Marine Parameter Observations

G. Coro
Environmental Modelling & Software. Elsevier, 2023.



Conceptualisation of the Bayesian hierarchical model used in our workflow. The small image representing the Gibbs sampling convergence process was taken from Dong et al. (2019).

Ecological and ecosystem modellers frequently need to interpolate spatiotemporal observations of geophysical and environmental parameters over an analysed area. However, particularly in marine science,

modellers with low expertise in oceanography and hydrodynamics can hardly use interpolation methods optimally. This paper introduces an Open Science oriented, open-source, scalable and efficient workflow

for 2D marine environmental parameters. It combines a fast, efficient interpolation method with a Bayesian hierarchical model embedding the stationary advection-diffusion equation as a constraint. Our workflow fills the usability gap between interpolation software providers and the users' communities. It can run entirely automatically without requiring expert parametrization. It is also available on a cloud computing-platform, with a Web Processing Service compliant interface, supporting collaboration, repeatability, reproducibility, and provenance tracking. We demonstrate that our workflow produces comparable results to a state-of-the-art model (frequently used in oceanography) in interpolating four environmental parameters at the global scale.

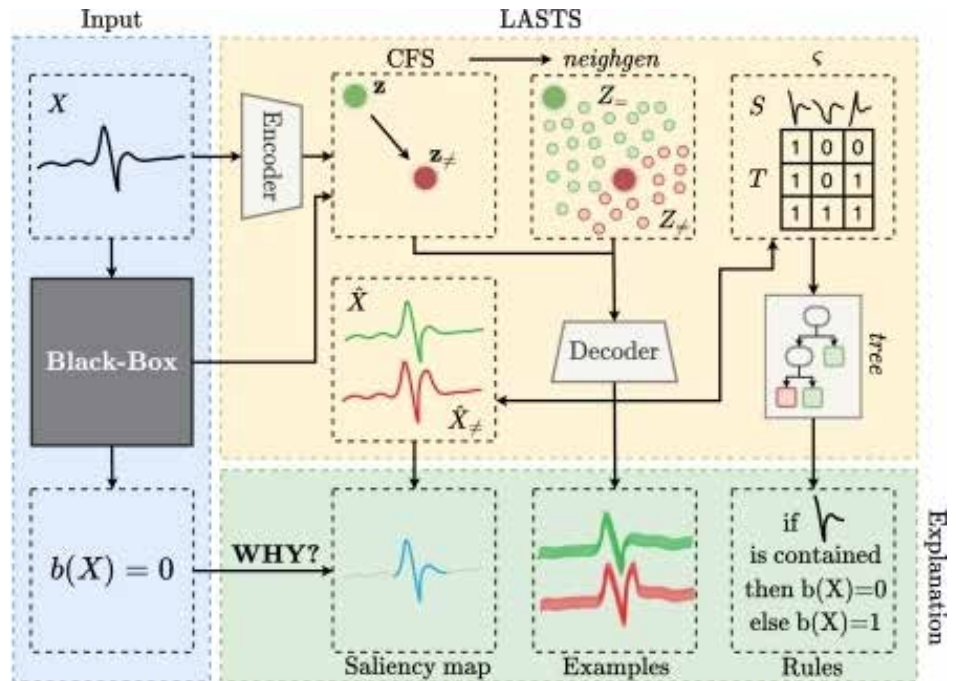
DOI: 10.1016/j.envsoft.2023.105901

Understanding Any Time Series Classifier with a Subsequence-based Explainer

F. Spinnato, R. Guidotti, A. Monreale, M. Nanni, D. Pedreschi, F. Giannotti
ACM Transactions on Knowledge Discovery from Data, vol. 18. ACM, 2023.

The growing availability of time series data has increased the usage of classifiers for this data type. Unfortunately, state-of-the-art time series classifiers are black-box models and, therefore, not usable in critical domains such as healthcare or finance, where explainability can be a crucial requirement. This paper presents a framework to explain the predictions of any black-box classifier for univariate and multivariate time series. The provided explanation is composed of three parts. First, a saliency map highlighting the most important parts of the time series for the classification. Second, an instance-based explanation exemplifies the black-box's decision by providing a set of prototypical and counterfactual time series. Third, a factual and counterfactual rule-based explanation, revealing the reasons for the classification through logical conditions based on subsequences that must, or must not, be contained in the time series. Experiments and benchmarks show that the proposed method provides faithful, meaningful, stable, and interpretable explanations.

DOI: 10.1145/3624480



A schema of lasts. (left) the input of lasts is composed of an instance X and the black-box prediction for that instance, $b(X)$. (bottom-right) the output of lasts is an explanation e composed of a saliency map, exemplars and counterexemplars, and factual and counterfactual decision rules. (top-right) lasts exploits the latent encoding of a VAE to perturb the time series and generate a synthetic neighborhood around the local decision boundary. Once decoded and classified by the black-box, these synthetic instances represent meaningful exemplar and counterexemplar time series and are used to construct a saliency map. Finally, interpretable subsequences are extracted from this neighborhood and used to train a decision tree surrogate, from which the factual and counterfactual rules are inferred.

From Fossil Fuel to Electricity: Studying the Impact of EVs on the Daily Mobility Life of Users

M. Nanni, O.I. Alamdari, A. Bonavita, P. Cintia
IEEE Transactions on Intelligent Transportation Systems, in press. IEEE, 2023.

Electric Vehicles (EVs) currently provide a major opportunity to decarbonize urban areas and improve their quality of life, however, the mass transition towards electric mobility requires understanding and solving the potential issues that they might cause to users. In this work, we propose a process

that, through a mix of mobility data analytics, efficient trip planning, and simulation heuristics, is able to analyze the current fuel-based mobility of a user and quantitatively describe the impact of switching to EVs on their mobility lifestyle. We apply our process to a large dataset of real trips,

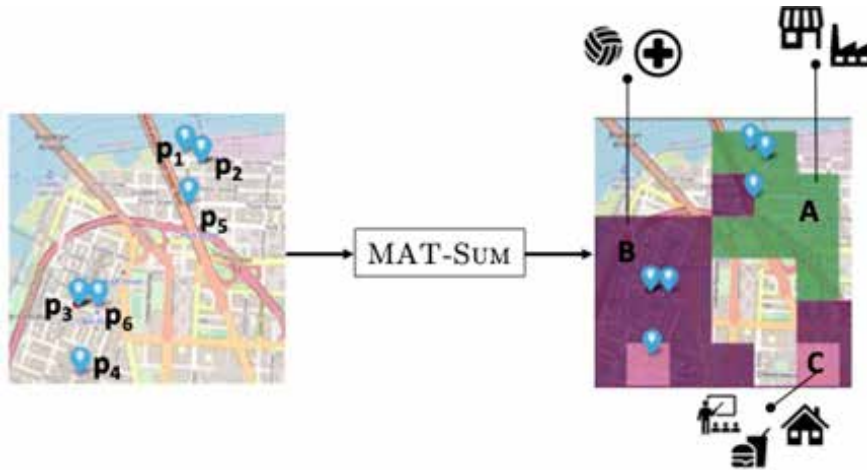
analyzing both the impact of EVs on the collectivity and on the individuals, providing a case study with insights at the level of single users.

DOI: 10.1109/TITS.2023.3340742

Summarizing Trajectories Using Semantically Enriched Geographical Context

C. Pugliese, F. Lettich, F. Pinelli, C. Renso

31st ACM International Conference on Advances in Geographic Information Systems. ACM, 2023.



The MAT-Sum summarization process.

In today's world, an abundance of mobility data is generated by devices equipped with tracking sensors. Moreover, there is an important line of research that enriches such data with diverse semantic information (i.e., aspects), thereby resulting in semantic or multiple aspect trajectories. The existing approaches present several challenges. Firstly, the data generated can be massive, characterized by high sampling rates, while the semantic aspects can be heterogeneous and have many associated attributes. Consequently, the resulting complexity requires significant storage resources and computational capabilities to ensure effective analysis and meaningful interpretation. To overcome these challenges, researchers have focused on developing methods to reduce the volume of mobility data through summarization or simplification of trajectories. This paper aims to summarize the vast amount of mobility data while preserving their seman-

tic information. We propose a location-centric enrichment perspective, which complements the trajectory-centric approach of the state-of-the-art, to achieve the summarization objective. This perspective enables spatio-temporal and semantic information aggregation, resulting in a more concise representation of mobility data. To address the aforementioned objectives, we aim to answer the following research questions: **RQ1)** How can we devise a trajectory summarization method that meaningfully leverages the semantic context of the underlying geographical area? **RQ2)** To what extent is the summarization method effective in summarizing semantic trajectories?

We begin our investigation from the first research question and address the underlying problem by introducing the MAT-Sum method. MAT-Sum's key idea is to consider

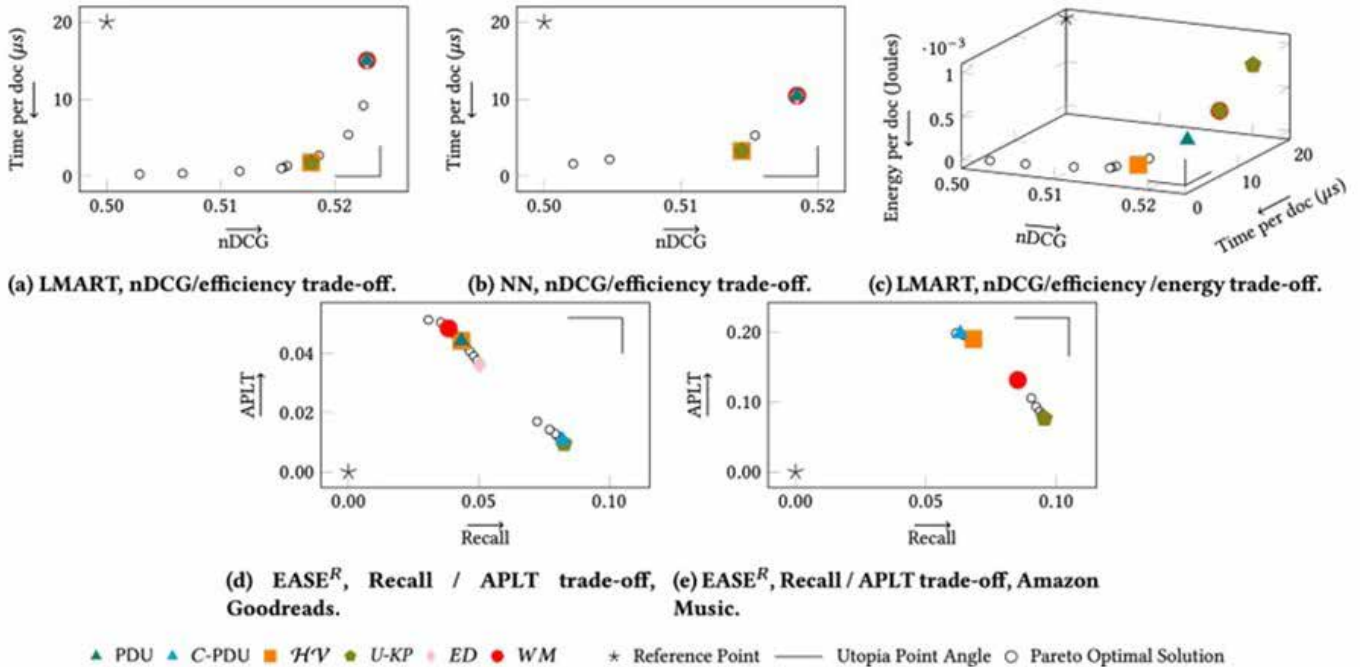
the geographical area where trajectories move and use it both for their semantic enrichment and summarization. To this end, MAT-Sum first partitions geographical area into cells, and then enriches each cell with semantic aspects. Subsequently, MAT-Sum leverages the enriched cells to obtain the summarized semantic trajectories from the initial ones. More specifically, each trajectory is discretized into the set of enriched cells it traverses. During the discretization, the cells serve a dual purpose: they not only enrich the trajectory with their semantic contexts in a location-centric way but are also used to condense the information concerning its movements and any semantic information it might possess. We call the final result a summarized semantic trajectory. For what concerns the second research question, in the experimental evaluation we assess MAT-Sum's effectiveness by considering two orthogonal and contrasting aspects: minimizing the information contained in the summarized semantic trajectories while simultaneously preserving an adequate level of semantic quality. Consequently, we evaluate our approach with two distinct datasets over different scenarios and compare its ability to obtain high-quality summarized semantic trajectories w.r.t. two baseline methods, i.e., RLE and Seqscan-D. Overall, MAT-Sum successfully accomplishes its goals.

DOI: 10.1145/3589132.3625587

Post-hoc Selection of Pareto-Optimal Solutions in Search and Recommendation

V. Paparella, V.W. Anelli, F.M. Nardini, R. Perego, T. Di Noia

32nd ACM International Conference on Information and Knowledge Management. ACM, 2023.



Pareto-optimal solutions for the IR and RS scenarios. The colored shapes represent the best—Pareto-optimal—point selected by the strategies under evaluation.

Many tasks in Information Retrieval (IR) and Recommender Systems (RSs) involve optimizing multi-objective functions. For example, consider the IR task of diversifying search results where, given a user query, we require the system to return a list of results that are both relevant for the user and diverse concerning the possible “facets” of the query. Addressing this task asks for designing a two-objective ranking function comprehensively maximizing the result list’s relevance and diversity. The same considerations can be made for RSs: despite the accuracy of recommendation being considered the gold measure to assess the quality of suggestions, over the last years, RSs have been required to meet other beyond-accu-

racy metrics to avoid trivial and unfair recommendations. Therefore, choosing a ranking/recommendation model and its setting entail several criteria leading to a trade-off among different objective functions. Solving multi-objective problems leads to a set of Pareto-optimal solutions, known as the Pareto frontier, in which no objective can be further improved without hurting others. In principle, all the points on the Pareto frontier are potential candidates to represent the best model selected with respect to the combination of two, or more, metrics. To our knowledge, no well-recognized strategies exist to decide which point should be selected on the frontier in IR and RSs. This paper proposes a novel, post-hoc, theoret-

ically-justified technique, named “Population Distance from Utopia” (PDU), to identify and select the one-best Pareto-optimal solution. PDU considers fine-grained utopia points, and measures how far each point is from its utopia point, allowing the selection of solutions tailored to user preferences, a novel feature we call “calibration”. We compare PDU against state-of-the-art strategies through extensive experiments on tasks from both IR and RS, showing that PDU combined with calibration notably impacts solution selection.

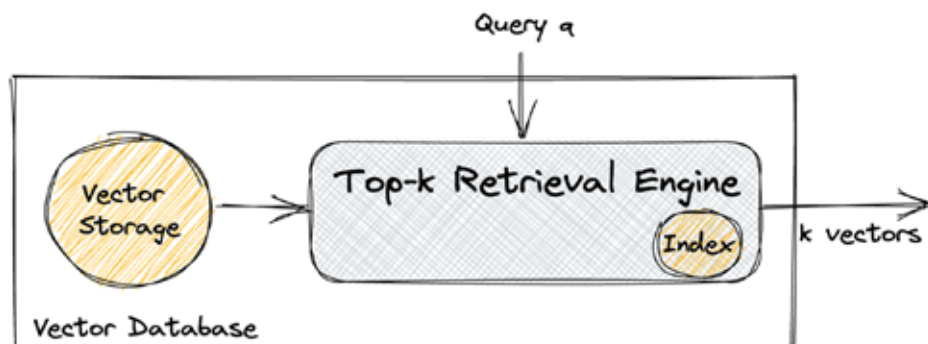
DOI: 10.1145/3583780.3615010

An Approximate Algorithm for Maximum Inner Product Search over Streaming Sparse Vectors

S. Bruch, F.M. Nardini, A. Ingber, E. Liberty

ACM Transactions on Information Systems, vol 42. ACM, 2023.

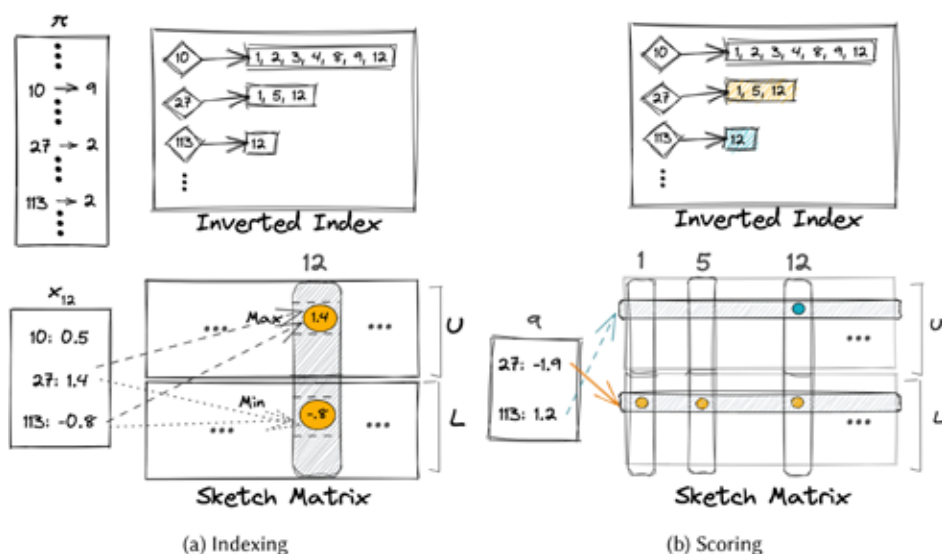
Maximum Inner Product Search or top-k retrieval on sparse vectors is well understood in information retrieval, with several mature algorithms that solve it exactly. However, all existing algorithms are tailored to text and frequency-based similarity measures. To achieve optimal memory footprint and query latency, they rely on the near stationarity of documents and on laws governing natural languages. We consider, instead, a setup in which collections are streaming—necessitating dynamic indexing—and where indexing and retrieval must work with arbitrarily distributed real-valued vectors. As we show, existing algorithms are no longer competitive in this setup, even against naïve solutions.



A vector database system consisting of a storage system and an exact or approximate top-k retrieval engine that solves the MIPS/SMIPS problem of Equation (2).

We investigate this gap and present a novel approximate solution, called Sinnamon, that can efficiently retrieve the top-k results for sparse real-valued vectors drawn from

arbitrary distributions. Notably, Sinnamon offers levers to trade off memory consumption, latency, and accuracy, making the algorithm suitable for constrained application-sand systems. We give theoretical results on the error introduced by the approximate nature of the algorithm and present an empirical evaluation of its performance on two hardware platforms and synthetic and real-valued datasets. We conclude by laying out concrete directions for future research on this general top-k retrieval problem over sparse vectors.



Example of (a) indexing and (b) score computation in Sinnamon. When inserting the vector $x_{12} \in \mathbb{R}^n$ consisting of three non-zero coordinates $\{10, 27, 113\}$, we first populate the inverted index and then insert a sketch of x into the 12th column of the sketch matrix. The top half of the matrix, U , records the upperbounds and the bottom half, L , the lowerbounds, with the help of a single random mapping π from n to m . When computing the approximate inner product of a query vector q with the documents in the collection, we look up the inverted list for one coordinate and traverse its corresponding row in the sketch matrix to accumulate partial scores in a coordinate-at-a-time algorithm.

DOI: 10.1145/3609797

Efficient Adaptive Ensembling for Image Classification

B. Antonio, D. Moroni, M. Martinelli

Expert Systems, early view. Wiley, 2023.

In recent times, with the exception of sporadic cases, the trend in computer vision is to achieve minor improvements compared to considerable increases in complexity. To reverse this trend, we propose a novel method to boost image classification performances without increasing complexity. To this end, we revisited ensembling, a powerful approach, often not used properly due to its more complex nature and the train-

ing time, so as to make it feasible through a specific design choice. First, we trained two EfficientNet-b0 end-to-end models (known to be the architecture with the best overall accuracy/complexity trade-off for image classification) on disjoint subsets of data (i.e., bagging). Then, we made an efficient adaptive ensemble by performing fine-tuning of a trainable combination layer. In this way, we were able to outperform the state-

of-the-art by an average of 0.5% on the accuracy, with restrained complexity both in terms of the number of parameters (by 5–60 times), and the Floating point Operations Per Second FLOPS by 10–100 times on several major benchmark datasets.

DOI: 10.1111/exsy.13424

Managing Coastal Aquifer Salinity Under Sea Level Rise Using Rice Cultivation Recharge for Sustainable Land Cover

I. Abd-Elaty, G.A.H. Sallam, L. Pugliese, A.M. Negm, S. Straface, A. Scozzari, A. Ahmed

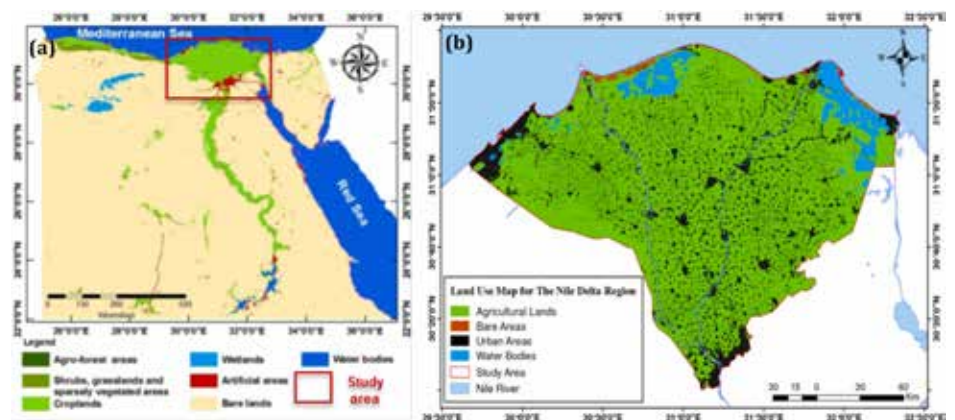
Journal of Hydrology: Regional Studies, vol. 48. Elsevier, 2023.

Study region: The coastal aquifer of Nile Delta, Egypt is used to develop the current study.

Study focus: Excess water from rice irrigation is a source of incidental recharge to mitigate seawater intrusion. This paper numerically explores the optimal location of rice cultivations by subdividing the delta domain into three distinct recharging regions (north, central and south). Additionally, SEAWAT code was simulated under a combination of rice cultivation relocation and sea level rise (SLR).

New hydrological insights for the region:

The study findings revealed significant variations in salt volume reduction depending on the location of rice cultivation in the delta. Placing rice cultivation in the northern region resulted in the highest reduction of salt volume (19 %). In contrast, locating the recharge in the central region yielded a salt volume reduction of 0.50 %, while rice cultivation in the southern region produced a 15 % increase. Considering the projected SLR of 61 cm by 2100, there was an over-



Study area for (a) location map (Yossif, 2019) and (b) Land use/land cover (LULC) for the Nile Delta Aquifer (NDA) (El-Quilish et al., 2023).

all salt volume increment of 3 %. However, when accounting for both SLR and rice cultivation recharge in the northern region, a substantial salt volume reduction of 17 % was observed. The results demonstrated that incidental recharge by rice cultivation in coastal aquifers is an effective method for enhancing saltwater intrusion control.

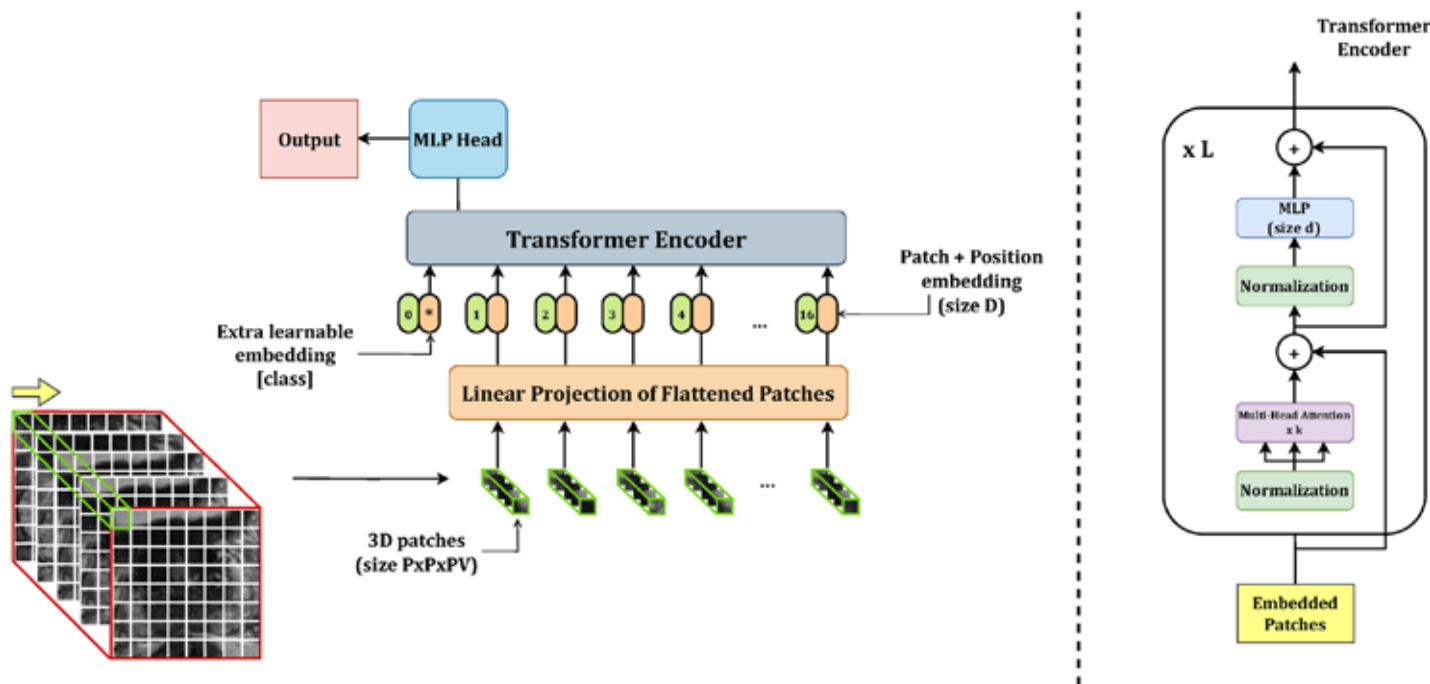
Moreover, this study improves our understanding of hydrological processes and expected responses in the delta under future climate scenarios.

DOI: 10.1016/j.ejrh.2023.101466

3D-Vision-Transformer Stacking Ensemble for Assessing Prostate Cancer Aggressiveness from T2w Images

E. Pachetti, S. Colantonio

Bioengineering, vol. 10. MDPI, 2023.



Base 3D ViT.

Vision transformers represent the cutting-edge topic in computer vision and are usually employed on two-dimensional data following a transfer learning approach. In this work, we propose a trained-from-scratch stacking ensemble of 3D-vision transformers to assess prostate cancer aggressiveness from T2-weighted images to help radiologists diagnose this disease without performing a biopsy. We trained 18 3D-vision transformers on T2-weighted axial acquisitions and combined them into two- and three-model stacking ensembles. We defined two

metrics for measuring model prediction confidence, and we trained all the ensemble combinations according to a five-fold cross-validation, evaluating their accuracy, confidence in predictions, and calibration. In addition, we optimized the 18 base ViTs and compared the best-performing base and ensemble models by re-training them on a 100-sample bootstrapped training set and evaluating each model on the hold-out test set. We compared the two distributions by calculating the median and the 95% confidence interval and performing a Wilcoxon

signed-rank test. The best-performing 3D-vision-transformer stacking ensemble provided state-of-the-art results in terms of area under the receiving operating curve (0.89 [0.61–1]) and exceeded the area under the precision–recall curve of the base model of 22% ($p < 0.001$). However, it resulted to be less confident in classifying the positive class.

DOI: 10.3390/bioengineering10091015

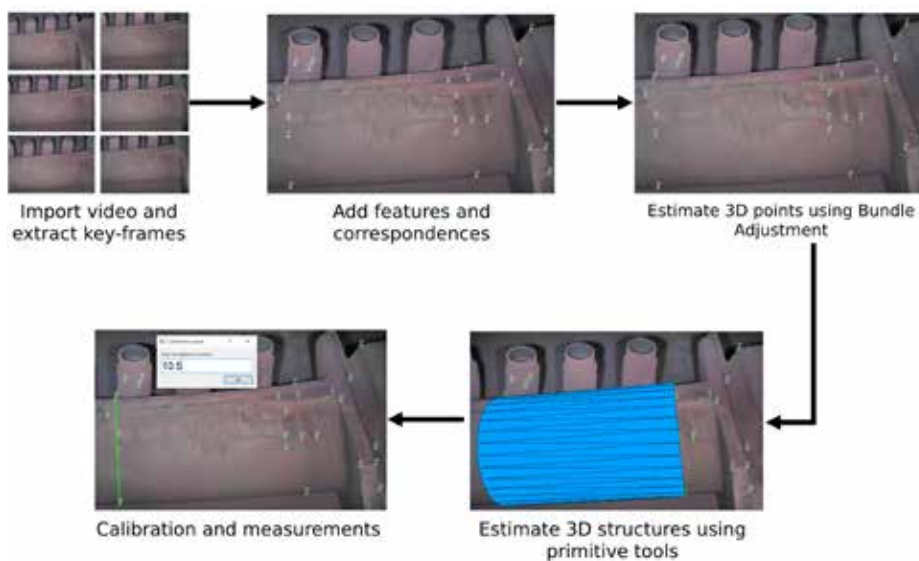
MoReLab: a Software for User-Assisted 3D Reconstruction

A. Siddique, F. Banterle, M. Corsini, P. Cignoni, D. Sommerville, C. Joffe
Sensors, vol. 23. MDPI, 2023.

We present MoReLab, a tool for user-assisted 3D reconstruction. This reconstruction requires an understanding of the shapes of the desired objects. Our experiments demonstrate that existing Structure from Motion (SfM) software packages fail to estimate accurate 3D models in low-quality videos due to several issues such as low resolution, featureless surfaces, low lighting, etc. In such scenarios, which are common for industrial utility companies, user assistance becomes necessary to create reliable 3D models. In our system, the user first needs to add features and correspondences manually on multiple video frames. Then, classic camera calibration and bundle adjustment



Examples of frames from videos captured in industrial environments. These videos are not suitable for automatic SfM tools due to issues such as low resolution, aggressive compression, strong and moving directional lighting (e.g., a torchlight mounted on the camera), motion blur, featureless surfaces, liquid turbulence, low lighting, etc.



MoReLab reconstruction pipeline.

are applied. At this point, MoReLab provides several primitive shape tools such as rectangles, cylinders, curved cylinders, etc., to model different parts of the scene and export 3D meshes. These shapes are essential for modeling industrial equipment whose videos are typically captured by utility companies with old video cameras (low resolution, compression artifacts, etc.) and in disadvantageous lighting conditions (low lighting, torchlight attached to the video camera, etc.). We evaluate our tool on real industrial case scenarios and compare it against existing approaches. Visual comparisons and quantitative results show that MoReLab achieves superior results with regard to other user-interactive 3D modeling tools.

DOI: 10.3390/s23146456

Geometric Deep Learning for Statics-Aware Grid Shells

A. Favilli, F. Laccone, P. Cignoni, L. Malomo, D. Giorgi
Computers & Structures. Elsevier, 2023.

This paper introduces a novel method for shape optimization and form-finding of free-form, triangular grid shells, based on geometric deep learning. We define an architecture which consumes a 3D mesh representing the initial design of a free-form grid shell, and outputs vertex displacements to get an optimized grid shell that minimizes structural compliance, while preserving

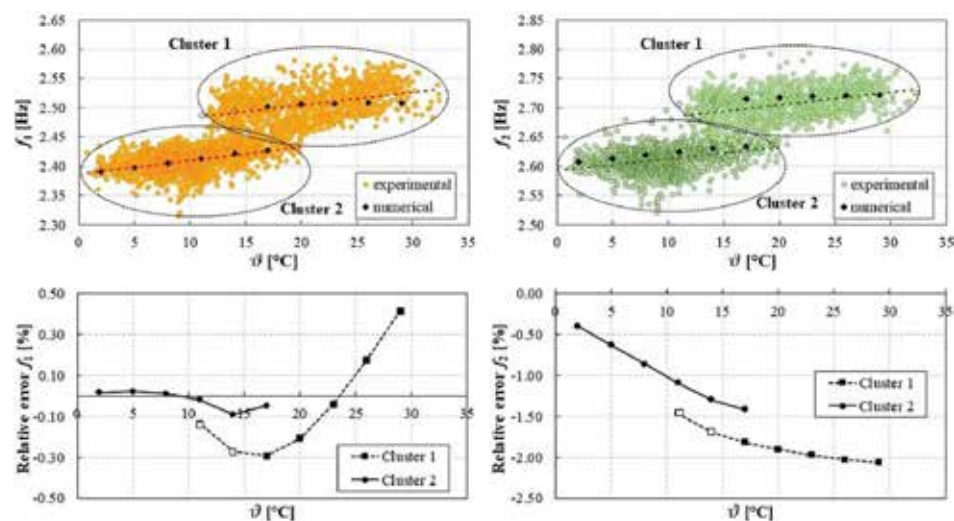
design intent. The main ingredients of the architecture are layers that produce deep vertex embeddings from geometric input features, and a differentiable loss implementing structural analysis. We evaluate the method performance on a benchmark of eighteen free-form grid shell structures characterized by various size, geometry, and tessellation. Our results demonstrate that

our approach can solve the shape optimization and form finding problem for a diverse range of structures, more effectively and efficiently than existing common tools.

DOI: 10.1016/j.compstruc.2023.107238

Effects of Temperature Variations on the Modal Properties of Masonry Structures: an Experimental-Based Numerical Modelling Approach

D. Pellegrini, A. Barontini, M. Girardi, P.B. Lourenço, M.G. Masciotta, N. Mendes, C. Padovani, L.F. Ramos
Structures, vol. 53. Elsevier, 2023.



Up: Experimental (circular dots) versus numerical (rhomboid black dots) trend of the two first frequencies of Mogadouro clock tower. Bottom: Relative error between the interpolated values of the experimental frequencies (on the regression line) and the numerical counterparts.

Long-term ambient vibration monitoring campaigns show that environmental parameters (such as temperature, humidity, wind speed and direction) can influence the structures' static and dynamic behaviour. In

particular, thermal variations can affect the modal characteristics of ancient masonry constructions. The present work presents a procedure combining experimental and numerical steps to monitor, assess and model

the dynamic behaviour of masonry structures subjected to thermal loads. The procedure, grounded on the NOSA-ITACA, a finite element code (www.nosaitaca.it/software/) developed by ISTI-CNR for the analysis and calibration of masonry structures, is tested and validated through two numerical examples featuring analogous geometry but different stiffening elements, as well as through the simulation of a full-scale masonry structure, the Mogadouro clock tower in Portugal, monitored with accelerometers, and temperature and humidity sensors.

This research has been conducted within the framework of the projects "Masonry materials subjected to thermal loads: part II" (Short-Term Mobility Program, 2020) and "Revolution" (Progetti di Ricerca @CNR, 2022-2024) both funded by the Italian National Research Council.

DOI: 10.1016/j.istruc.2023.04.080

fib Conceptual Design Award 2023

The fib International Symposium on Conceptual Design of Concrete Structures, 29th June – 1st July 2023, Oslo, Sweden

Francesco Laccone and Sandro Menicagli (University of Pisa) have been awarded fib Conceptual Design Award 2023 in the category: young engineers and architects under the age of 35. The fib – International Federation for Structural Concrete – Fédération Internationale du Béton organizes a competition to address the current challenges in the design of concrete structures. The award is given for a solution that reflects sustainability, innovation and circular economy.

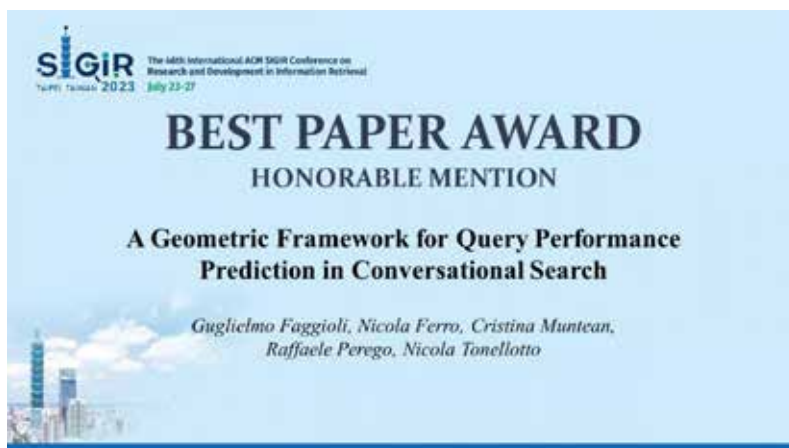
The poster “Static- and fabrication-aware concrete shells segmented into flat tiles” by Francesco Laccone and Sandro Menicagli was first selected as one of the 10 nomi-



nees on the shortlist for the prize and then awarded during the symposium dinner.

Contact: Francesco Laccone, VC Lab
francesco.laccone@isti.cnr.it

Best Paper Honorable Mention at ACM SIGIR 2023 Conference



A new method to evaluate and predict the effectiveness of Artificial Intelligence systems, such as voice assistants, in carrying out a conversation that meets the user’s expectations. This is the focus of the paper by Guglielmo Faggioli, Nicola Ferro, Cristina Ioana Muntean, Raffaele Perego, and Nicola Tonello awarded with the “ACM SIGIR 2023 Best Paper Award Honorable Mention” at the recent SIGIR conference (Conference on Research and Development in Information Retrieval” <https://sigir.org/sigir2023/>), held in Taiwan,

which annually brings together the major academic and industrial experts in information retrieval, the science behind search engines. The work saw collaboration between HPC Lab of ISTI-CNR, the University of Padua, and the Department of Information Engineering of the University of Pisa

“Search engines - explain the authors conducting cutting-edge research on Information Retrieval - are evolving from the simple “question-multiple answers” scenario (the

famous 10 blue links) to a “ conversational dialogue”, where the interaction is composed of multiple exchanges of questions and answers. A typical example consists of the interaction between humans and digital assistants such as Alexa and SIRI, the implementation of which is often based on “deep” neural networks.

The article proposes a new tool to predict the success of a digital assistant in answering the next question in a conversation, or to modify on the fly the behavior of a digital assistant in retrieving information to improve the quality of the answers processed. Our mathematical model estimates the “semantic distance” between a question and an answer, and therefore evaluates the system that best responds to user requests”.

Contact: Raffaele Perego, HPC Lab
raffaele.perego@isti.cnr.it
<https://sigir.org/sigir2023/program/best-paper-award/>

Best Short-paper Honorable Mention at SIGIR 2023

Performing Large-scale Search in Motion Data using Natural Language Queries

We were pleased to receive the best short-paper honorable mention for the paper "Text-to-Motion Retrieval: Towards Joint Understanding of Human Motion Data and Natural Language" (Nicola Messina, Jan Sedmidubsky, Fabrizio Falchi, Tomás Rebok) at SIGIR 2023, held in Taipei, Taiwan, from 23 to 27 July, 2023. This paper resulted from joint work at the AIMH laboratory of ISTI-CNR and the DISA laboratory of the Masaryk University of Brno (Czech Republic).

The research reported studies the possibility of employing the contrastive learning framework between text and motion data

for searching large motion databases using textual prompts as queries. Previously employed methods primarily relied on query-by-example paradigms, which required the creation of an example motion query to search for similar ones – an unpractical and time-consuming operation.

We proposed a set of model baselines derived from recurrent neural networks and motion transformers, and introduced metrics to quantitatively evaluate the ability of our models to retrieve relevant motions from textual descriptions. This study paved the way for a more in-depth exploration of

this interesting and so far unexplored problem.

The system proposed could be employed in a plethora of downstream applications, for example, from the medical domain – where we could search for gait or posture anomalies using motion-captured data – or the gaming and film industries – where animators might want to search for specific 3D animation assets in large motion capture databases.

Contact: Nicola Messina, AIMH Lab
nicola.messina@isti.cnr.it



Under 35 Years Best Paper Award at 17th International Workshop on Advanced Infrared Technology and Applications (AITA)



Francesco Conti was awarded the 6th Under 35 Years Best Paper Award at the 17th International Workshop on Ad-

vanced Infrared Technology and Applications (AITA), held in Venice, 11-13 September 2023.

This award aims to encourage innovative studies by young researchers in the topics of interest of the workshop. It is assigned in honour of Ermanno Grinzato, long-time AITA co-chairman and renowned scientist in the thermography community.

Francesco's paper "Alzheimer Disease Detection from Raman Spectroscopy of the Cerebrospinal Fluid via Topological Machine Learning" discussed how signals produced by the Raman scattering phenomenon could be captured and turned into interpretable information thanks to a blend of machine learning and topological data analysis, achieving results of significant potential impact in health-care.

Contact: Francesco Conti, SI Lab
francesco.conti@isti.cnr.it

Best Paper Award @XKDD 2023

At the 5th International Workshop on eXplainable Knowledge Discovery in Data Mining

Eleonora Cappuccio, Daniele Fadda, Rosa Lanzilotti and Salvatore Rinzivillo have won the Best Paper Award at the 5th International Workshop on eXplainable Knowledge Discovery in Data Mining, ECML/PKDD Conference, with the paper "FIPER: a Visual-based Explanation Combining Rules and Feature Importance".

Contact: Salvatore Rinzivillo, KDD Lab
salvatore.rinzivillo@isti.cnr.it



Best Long Paper Award

At Crossing HCI and AI, 20 - 22 September 2023, Turin, Italy

The paper "MCI Older Adults' User Experience with Introverted and Extraverted Humanoid Robot Personalities" by Eleonora Zedda, Marco Manca, Fabio Paternò, Carmen Santoro has been conferred with the Best Paper Award at CHIItaly.

This study aimed to investigate the impact of different personalities in humanoid robots for cognitive training scenarios with

older adults with mild cognitive impairment (MCI). In particular, we have designed an application with two opposite personalities based on the Extraversion dimension of the Big Five Factors model. A user test with 16 Italian-speaking participants diagnosed with MCI aged 68+ was performed.

The analysis of the data collected suggests that the robot's personality can have an effect on the engagement of such users and

also found that participants can discriminate between the two personalities. Overall, the study highlights the importance of designing human-robot interactions considering personality-related aspects when considering MCI older adults.

Contact: Eleonora Zedda, HIIS Lab
eleonora.zedda@isti.cnr.it



CNR and FINCANTIERI obtain an EU Patent for a System and Method for Supporting an Operator for Navigation

Fincantieri and the National Research Council (CNR) have presented the results of six multidisciplinary research projects as part of the Ministry of Infrastructure and Transport's naval innovation funding. In these six projects, CNR acted as scientific coordinator, involving nine institutes from the Department of Engineering, ICT and Technologies for Energy and Transport (CNR-Diitet), one from the Department of Chemical Sciences and Materials Technologies (CNR-Dsctm), and three universities (Genoa, Trieste, and Rome Sapienza). The entire program is part of Fincantieri's Open Innovation strategy whereby companies develop networks of expertise, linking their suppliers, universities, and research centers in order to cooperate in solving complex problems.

In this approach, CNR has played the role of innovation 'hub' acting as an 'entry point' to the public research system, selecting skills, collecting results, and, with the support of the industrial partner, coordinating the work of synthesizing the many objectives achieved in an overall road-map. In particular, one of the six projects, E-Navigation, led by ISTI-CNR, STIIMA-CNR, and the University of Genoa, has designed a mixed reality system of now-casting and

control, integrated with the steering and propulsion systems of a naval vessel. This provides decision support information projected both onto the glasses of the bridge officers and ashore, through a satellite-aided telemetry-data distribution system.

The system has been granted an Italian patent "System and method for supporting an operator for navigation" in 2022 under No. 102020000010105. The Italian application was extended to the European Patent Office, granted in 2023 with application no. EP3907470B1 and validated in France, Germany, Great Britain, Norway, Italy, Greece, The Netherlands, and Turkey.

This patent addresses a crucial aspect concerning the safety of a ship or vessel and the personnel aboard, i.e., the choice of maneuvers to which an operator must resort to reduce as far as possible the risk of collision with an obstacle, whether another ship, a floating structure, a person at sea or the mainland. Ships nowadays are typically equipped with hardware and software capable of acquiring information representative of the ship and the obstacle and, from a computational point of view, processing this data to provide useful information to support an operator in evaluating the necessary

maneuvers.

The patent addresses issues regarding the time required to acquire and process this information, some of which can also be obtained remotely (e.g., through a satellite connection), and how the information is presented to the operator. This data is crucial in providing effective and reliable decision-making support.

The authors are: Luca Sebastiani (Fincantieri), Pietro Cassarà, Maria Di Summa, Alberto Gotta, Giovanni Paolo Viganò and Marco Sacco (CNR_DIITET), Massimo Figari, Michele Martelli and Raphael Zacconel (University of Genoa).

Italian Patent 102 020 000 010 105, May 2022

European Patent (France, Germany, Great Britain, Norway, Italy, Greece, Netherlands, Turkey) 3907470B1, Feb. 2023

Contact: Alberto Gotta, WNLab

alberto.gotta@isti.cnr.it

<https://www.fincantieri.com/it/media/comunicati-stampa-e-news/2019/fincantieri-e-cnr-innovazione-in-campo-navale/>

The Tenth IPIN Indoor Localisation Competition 2023

32 teams from around the world compete to find the best indoor localisation system, both on site and off site.

The IPIN indoor Localisation competition reached its tenth year, with 32 teams from Europe and Asia competing in seven different Tracks, each posing a different challenge to competitors.

The teams participating in Track 1 “Smart-phone” came to the Museum of Industrial Culture in Nürnberg (DE) with their own indoor localisation system installed on their smartphone. After tuning their systems within the museum during Saturday, on Sunday the competitors followed a previously unknown path inside the museum with their systems making a continuous recording of their estimated position. A series of reference points on the floor and an appropriate measurement procedure allowed the organ-

isers to evaluate the positioning error of the users, who moved in a natural way along a walk of 20-minutes, including stops and sit-downs. The winner’s results achieved an all-time low, with a median error of 1.6 m and a third quartile of 2.9 m. These figures are much higher than those found in the literature, which are usually computed in a well-known and limited environment without independent overview. However, they represent the “real” state of the art of generic indoor localisation systems for pedestrians on smartphones without a dedicated infrastructure.

The remaining Tracks were off-site: competitors were not requested to test in-person, but interacted with a real-time emulator

that continuously provided their localisation systems with pre-recorded sensor data while gathering the competing system position estimate.

An overview of the competition criteria can be found at evaal.aaloo.org, with the settings of all Tracks in the 2023 directory, while a more formal description can be found in *Comparing the Performance of Indoor Localization Systems through the EvAAL Framework*, Sensors, 2017

Contact: Francesco, Potorti, WN Lab

Potorti@isti.cnr.it

<https://evaal.aaloo.org/>



Path of the underground floor with errors for the thws team, winner of Track 1 (Markus Ebner, Steffen Kastner, Markus Bullmann, Toni Fetzer, Frank Deinzer) from the Technische Hochschule Würzburg-Schweinfurt. Green dots are reference points, small blue circles are estimated points, red lines show error size.

Ph.D. dissertations

Personalities in Humanoid Robots for Cognitive Training of Older Adults

Author: Eleonora Zedda, University of Pisa, ISTI-CNR, Pisa, Italy

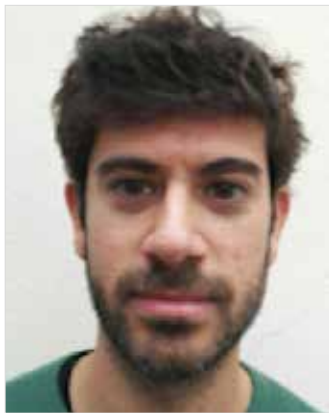
Supervisors: Fabio Paternò ISTI-CNR, Daniele Mazzei (University of Pisa)

In the last decade, the ageing of the population is occurring worldwide, and ageing increases the degeneration in the cognitive and physical domains of older adults. For this reason, technologies to support older adults in trying to slow down the progression of cognitive impairment are becoming more and more important. In particular, humanoid robots with social skills are increasingly common in the real world. Although life expectancy is increasing, the quality of life is not necessarily doing so. Thus, we may find ourselves and our loved ones dependent and in need of another person to perform the most basic tasks, which has a strong negative psychological impact. As a result, social robots may be the definitive tool to improve the quality of life by empowering people dependent on others and extending their independent living. In this context, humanoid robots can be an effective tool for the cognitive training of older adults, and to achieve this, their interaction with humans must be engaging. In this Thesis, we seek to understand if proposing robots with extraverted or introverted personalities could improve the user experience during a seri-

ous game scenario. Specifically, we design, implement, refine, and test a set of verbal and nonverbal parameters for such personality traits, which are general and potentially have different fields of application. The two personalities are implemented in an application that proposes typical cognitive training exercises using a Pepper robot. Additionally, we identify the requirements for designing and implementing a serious game to be a useful tool to be included in cognitive training. After evaluating the robot personalities with different tests and interviews with 52 users, including experts, healthy older adults and users with mild cognitive impairment, we address the problem of how to improve engagement and adaptation for older adults during repetitive cognitive training. The monotonous nature of repetitive cognitive training may cause older adults to lose interest and drop out. Social robots are used to reduce boredom and cognitive load when playing serious games as part of cognitive training, indeed. In this Thesis, a behaviour-adaptation technique is proposed to select the best actions, which consist of a combination of verbal and non-verbal interac-

tion aspects, for the robot to maintain the attention level of older adult users during a serious game. The behaviour-adaptation technique proposed allows the robot to autonomously select the most appropriate actions to maintain the level of engagement of older adults during the full interaction session. After a session with 28 users, where both the adaptive and non-adaptive robot is used, a test to evaluate the adaptive behaviour of the robot is performed. The findings demonstrate users' ability to differentiate between the behaviours exhibited by the adaptive and non-adaptive robot. The users perceived the adaptive robot as displaying greater adaptability and engagement than the non-adaptive robot. This adaptability contributed to a more engaging and motivating user interaction with the robot. In summary, we provide a system and the guidelines to design a robotic behaviour of the future. The robot is able to autonomously adapt its personality to increase user engagement and experience, stimulating the users to continue the cognitive training.

Welcome aboard!



Luca Ciampi

Research Staff (Ricercatore)
AIMH Lab



Said Daoudagh

Research Staff (Ricercatore)
SI Lab



Raihana Ferdous

Research Staff (Ricercatrice)
FMT Lab



Andrea Mattioli

Research Staff (Ricercatore)
HIIS Lab



Cosimo Rulli

Research Staff (Ricercatore)
HPC Lab

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Editorial Secretariat

segreteria scientifica@isti.cnr.it

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