Vigoni Ricerca

Current problems and opportunities in AI applications

Villa Vigoni, July 21-22, 2023

Program and Abstracts

A vision on eXtended Reality : the SUN XR (Social and hUman ceNtered XR) project

Giuseppe Amato - CNR-ISTI

Extended Reality builds upon augmented and mixed reality, which in turn build on top of Virtual Reality. Virtual reality allows you to access virtual worlds using visors, smart devices, or computer screens. However, you are isolated from the real world. With augmented and mixed reality, the virtual world is overlayed on top of the physical world. Virtual objects are fused and synchronized with the physical world. In mixed reality, users can interact both with physical and virtual objects.

Extended reality goes a step beyond. It is not limited to the visual dimension. With extended reality, interaction between the two worlds becomes more realistic. Users can feel virtual objects. They can feel their weight. They can feel their temperature. They can feel their consistency.

In the SUN (Social and hUman ceNtered XR) project, we have identified the current limitations, to make XR real and easily usable, and we are addressing them. We will validate the developed solutions in three different pilot applications related to three social and human related scenarios: rehabilitation, safety and training in industry, and aid to people with reduced mobility capabilities.

Dr. Giuseppe Amato (PhD in Computer Science from Universität Dortmund) is research director at CNR-ISTI Pisa and leads the "AI for Multimedia and Humanities" laboratory (AIMH, http://aimh.isti.cnr.it/) His main research interests are Artificial Intelligence and Multimedia Information Retrieval. He has published over 150 papers in international journals. He participated in several EU and national research actions, and currently coordinates the Social and hUman ceNtered XR (SUN) project (https://www.sun-xr-project.eu/) funded by Horizon Europe Research & Innovation Programme. More at http://aimh.isti.cnr.it/giuseppeamato/

Medieval manuscripts meet Machine learning: the experience of 'In codice ratio'

Serena Ammirati - Università di Roma Tre

For some years now, our research team has been developing tools for the analysis and study of medieval manuscript sources using, in addition to traditional palaeographic skills, machine learning techniques. Our automatic transcription software, applied to the papal registers of Honorius III preserved in the Vatican Apostolic Archive, has given encouraging results; today, with some adaptations, it is applied to the transcription of 12th and 13th century parchments from the fund of Saints Cosmas and Damian preserved in the State Archive of Rome (approximately 200 documents), which have been edited and/or regested only in part. The transcription of the parchments is accompanied by a census of the scriniarii involved and a study of their writing practices, which is in turn the basis for a machine learning experiment dedicated to hand recognition and identification, supported by a focus on the explainability of the results obtained.

Serena Ammirati, PhD, is associate professor of Paleography at Roma Tre University. She studies the forms of ancient, medieval and modern handwriting, analysing their evolution, supports, and contexts of circulation and production. Serena has a particular interest in papyrus writings (Greek and especially Latin) and in the forms of the book in the West (especially in Rome); she also work on the writings of law and on artificial intelligence applied to manuscripts in the frame of the project "In Codice Ratio".

Chatbot in the Museum

Vanshika Bawa - DFKI Berlin

The development and impact of the project "CHIM - Chatbot in the museum" gives us an idea of the state-of-the-art of museum applications. As LLM technology continues to evolve, it raises intriguing possibilities for the future of museum chatbots. As a second part, the talk aims to present possibilities and challenges associated with retrieval augmented generation and provide insights into the advancements that await museum chatbots in the coming years.

Vanshika Bawa is an accomplished engineer with a strong background in neuroscience and a keen interest in the applications of AI. She holds a MSc in Computational Neuroscience from Albert Ludwigs Universität Freiburg, where she focused on understanding the dynamics of visual cognition using EEG recordings and eye tracking. During her academic journey, Vanshika developed a comprehensive understanding of topics such as reinforcement learning, deep learning, machine learning, and signal processing. Currently serving as a Scientific Researcher at the German Research Center for Artificial Intelligence (DFKI) GmbH in Berlin, Vanshika contributes to the development of AI-driven solutions in the field of Task-oriented chatbots.

Road towards a Responsible AI: the journey of Intesa Sanpaolo

Claudia Berloco - Intesa San Paolo

AI algorithms are currently experiencing a period of enormous success, they are becoming more and more widespread and used in various industries, including those providing services to people. This is unquestionably a good thing, as AI makes it possible to have more efficient processes, optimizing time and resources. However, AI brings along inevitably some risks. In this talk, we shall briefly overview 2 of such risks: 1. the risk of perpetuating and sometimes amplifying discrimination against particular groups within the population; 2. the challenge posed by the complexity and opacity of modern AI systems. We then focus on several initiatives launched by Intesa Sanpaolo throughout the course of its four years of investigation and dedication to the field of responsible AI.

Claudia Berloco is a Senior Data Scientist in Intesa Sanpaolo. She has over ten years of experience in Data Science and Artificial Intelligence projects and solutions. Her fields of expertise span from time series forecasting to natural language processing and complex network analysis. She received her PhD in Modeling and Data Science at Università di Torino in 2021. Before the present experience in the banking sector, she worked in the Energy and GDO sectors.

Towards Embodied Artificial Intelligence

Roberto Calandra - TU Dresden

The increasingly widespread use of robots has the potential to revolutionize both industrial applications and our everyday life. However, current robots are difficult to deploy and possess little adaptability. In this talk, I will be discussing how the use of AI can contribute towards making robots more useful and adaptable in the real-world. Moreover, I will present some of our recent work on the use of AI to provide robots with a sense of touch.

Roberto Calandra is Full (W3) Professor at TU Dresden and at the Centre for Tactile Internet with Human-in-the-Loop. Previously he founded at Facebook AI Research (now Meta AI) the Robotic Lab in Menlo Park. Prior to that he was a Postdoctoral Scholar at the University of California, Berkeley in the Berkeley Artificial Intelligence Research (BAIR) Lab. His education includes a PhD from TU Darmstadt (Germany), a MS in Machine Learning and Data Mining from Aalto university (Finland), and a BSc in Computer Science from Università di Palermo (Italy). His scientific interests are broadly at the conjunction of Robotics and Machine Learning. Roberto served as Program Chair for AISTATS 2020, as Guest Editor for the JMLR Special Issue on Bayesian Optimization, and co-organized over 14 workshops at international conferences (NeurIPS, ICML, ICLR, ICRA, IROS, RSS).

Challenges of AI text generation: thoughts from the field of (Romance) linguistics

Anna-Maria De Cesare - TU Dresden

This talk offers an overview of the challenges related to the use of AI large language models (LLMs) from the perspective of (Romance) linguistics. After a brief description of the opportunities opened by the availability of LLMs, the talk highlights some of the main problems associated with the presence, propagation, and enhancement of biases in automatically generated texts (e.g., by ChatGPT). Special attention will be paid to the category of linguistic biases. As a way of conclusion, a list of goals defining a new field of research is outlined.

Anna-Maria De Cesare holds a PhD in General Linguistics from the University of Geneva and a Habilitation in Italian and General Linguistics from the University of Basel. She currently holds the Chair of Romance Linguistics (French-Italian) at the TU Dresden. Her domains of expertise cover syntax, lexical semantics, sociolinguistics, contrastive linguistics, text linguistics, and theoretical pragmatics. She is currently developing a new research field in linguistics, centered on the study of AI-generated texts in the Romance languages.

Stochastic Parrots or True Believers: On LLMs as Intentional Systems

Fabio Ciotti - Università di Roma Tor Vergata

This talk challenges the widespread view of Large Language Models (LLMs) as mere "stochastic parrots" as articulated by Bender _et al,._ and argues for a nuanced understanding of these entities as "intentional systems," adopting the theoretical lens provided by Daniel Dennett. We argue that LLMs, particularly those based on transformer neural networks, exhibit a level of linguistic

competence that exceeds the simple regurgitation of learned patterns, challenging the parrot thesis on three fronts.

First, we argue that the parrot thesis rests on several unexamined qualitative assumptions, such as "communicative intent," "theory of mind," and "world model," which are poorly theorized and may be only partially necessary or applicable in the realm of machine learning models. However, according to various tests, LLMs may have some form of these properties, and their linguistic understanding gives them the adaptability to operate in different contexts. As an example, we will show some GPT-4 tests of complex reasoning (frame problem handling, mathematical proofs, narrative inference).

Second, we illustrate how the inner workings of transformer-based LLMs elude their representation as random string combinators. These models generate tokens based on intricate interactions between attention mechanisms and encoded representations, demonstrating semantically motivated linguistic production rather than stochastic mimicry.

Third, we believe that the parrot thesis overlooks emergent capabilities in large and complex LLMs, such as translation and rudimentary reasoning, that signal a form of "understanding" that goes beyond simple pattern matching.

Based on Dennett's theory of intentional systems, we argue that LLMs can be seen as intentional systems that possess a form of "as if" intentionality. The encoded representations of an LLM can be viewed as "beliefs" about the statistical properties of the text, while its goals can be interpreted as "desires." Considering LLMs through this lens offers a powerful tool for understanding and predicting their behavior. It also grants these systems a level of agency that respects their complex and nuanced linguistic capabilities.

The talk concludes that even if LLMs do not have human-like consciousness, they demonstrate a form of linguistic competence that can be appreciated within the framework of Dennett's intentional systems theory. This position invites a reconsideration of the role of LLMs in communicative acts, moving beyond the perception of these systems as mere tools and considering them as active participants in linguistic exchange, and specifically in research workflows, where the informed and mindful adoption of prompt engineering techniques can provide high-level outcomes.

Fabio Ciotti is Professor of Theory of literature and Cultural Analytics at the University of Roma "Tor Vergata." His research focuses on various strands of Digital Humanities and Computational Literary Studies. He is the author of several publications including Digital Humanities. Metodi strumenti e saperi (Carocci 2023); participated in research projects at the national and international levels; was organizer or program committee member of various national and international conferences and Chair of Program Committee of the DH2019 Conference (Utrecht 2019). He is Editor in Chief of the journal Umanistica Digitale, Chair of European Association of Digital Humanities, Executive Board, founding member and past President of Associazione per l'Informatica Umanistica e la Cultura Digitale.

Data save lives: Deep learning from health data

Roland Eils - Berlin Institute of Health (BIH), Charité, Berlin

In primary prevention, risk stratification is critical for the early identification of high-risk individuals. Beyond established clinical predictors, new biomarkers are regularly considered for clinical adoption. However, adoption into clinical practice not only requires a high additional prognostic value, but also practicability and affordability of predictors. Here, I will report on our ongoing efforts to employ machine learning for integration of data from clinical care, health records and research data for disease risk stratification. Using two examples, I will demonstrate the potential of such data integration efforts for almost all common conditions including metabolic, vascular, respiratory, musculoskeletal and neurological diseases and cancers.

Prof. Dr. Roland Eils is founding director of the BIH Digital Health Center at Charité −Universitätsmedizin Berlin and director of the Health Data Science unit at the Medical Faculty of Heidelberg University. He was previously founding and managing director of Heidelberg University's Systems Biology center BioQuant and Head of Division "Theoretical Bioinformatics" at DKFZ Heidelberg. His group has delivered significant contributions to the field of cancer genomics systems biology and digital health. Roland is member of the Organizing Committee of the Human Cell Atlas initiative and Coordinator of the HiGHmed Consortium. He coordinates the HEALTH-X dataLOFT ("Legitimierter, Offener und Föderierter Gesundheitsdatenraum in GAIA-X") consortium. Roland has published over 700 publications with over 65000 citations and an h-index of 112.

From Optimization to Artificial Intelligence, and back

Giovanni Felici - CNR-IASI

We will consider the main relations between the discipline of mathematical optimization and AI, with special focus on the machine learning methods that have recently contributed so much to the advancements of AI. We will discuss cases where machine learning has helped improve the solution of difficult optimization problems, and others where optimization approaches play a role in the extraction of high-quality knowledge from data. We will refer to two important concepts in modern data science – explainability and fairness – and finally provide few examples of ongoing research related to such topics.

Giovanni Felici is research director at CNR IASI, Istituto di Analisi dei Sistemi ed Informatica "A. Ruberti" in Rome. He specializes in optimization, operations research, data science, machine learning and artificial intelligence, and has been active in basic and applied research on optimization algorithms for bioinformatics, production, logistics, transportation, network science, urban intelligence. From 2016 to 2022 he was seconded at the European Research Council Executive Agency in Brussels.

Cognitive Assistance for Intelligent environments

Antonio Krüger - DFKI and U Saarbrücken

Assuming that most AI support in the near to midterm future will rely on supervision rather than on full automatisation, this talk discusses different ways to humans in the loop and stresses the importance of adapting methods of HCI to the control of AI-Systems. It first presents general thoughts on the direction AI is heading and then presents novel ways to control systems and interweave human and artificial intelligence.

Antonio Krüger is CEO and scientific director of the German Research Center for Artificial Intelligence GmbH (DFKI) and head of the department "Cognitive Assistants" at DFKI. He is full professor for Computer Science at Saarland University (since 2009), Head of the Ubiquitous Media Technology Lab and scientific director of the Innovative Retail Laboratory (IRL) at DFKI. Prof. Krueger is an internationally renowned expert on Man-Machine-Interaction and Artificial Intelligence. In 2010 he established the Mediainformatics study programme at the Saarland University and directs it to this day. Antonio is a co-founder of the Saarbrücken-based technology company Eyeled GmbH, which focuses on the development of mobile and ubiquitous information systems. Many of his research findings have found their way into applications in retail and other industrial domains. From 2004 to 2009 he was professor of computer science and geoinformatics at the University of Münster and acted as managing director of the institute for geoinformatics. He studied Computer Science and Economics at Saarland University and obtained a Ph.D in 1999 as a member of the Saarbrücken Graduate School of Cognitive Science. He published over 200 scientific papers in international journals and is member of many steering committees, editorial boards and scientific advisory committees.

From Explainable to Trustworthy AI

Wojciech Samek - TU Berlin

The emerging field of Explainable AI (XAI) aims to bring transparency to today's powerful but opaque deep learning models. This talk will present motivations and critically discuss different approaches to explaining models and their respective predictions. In particular, this talk will present Concept Relevance Propagation (CRP), a next-generation XAI technique which explains individual predictions in terms of localized and human-understandable concepts. Other than the related state-of-the-art, CRP not only identifies the relevant input dimensions (e.g., pixels in an image) but also provides deep insights into the model's representation and the reasoning process. By lifting XAI to the concept level, CRP opens up a new way to analyze, debug and interact with ML models, which is of particular interest in safety-critical applications and the sciences.

Wojciech Samek is professor at TU Berlin and head of AI at the Heinrich Hertz Institute (HHI) Berlin. He holds a PhD in computer science from TU Berlin and studied at Humboldt University, Heriot-Watt University and University of Edinburgh, with scholarships from the German Academic Scholarship Foundation and DFG Research Training Group GRK 1589/1. He was visiting researcher at NASA Ames Research Center, is associated faculty at BIFOLD, the ELLIS Unit Berlin, the DFG Research Unit DeSBi, and the DFG Graduate School BIOQIC, and scientific advisory board member of the Polish Centre of Innovation in Artificial Intelligence. He is senior editor of IEEE TNNLS, editorial board member of Pattern Recognition, elected member of the IEEE MLSP Technical Committee and of German Platform for Artificial Intelligence. He received multiple awards, including the 2020 Pattern Recognition Award and the 2022 Digital Signal Processing Prize, and is a developers of the ISO/IEC MPEG-17 NNC standard. He is leading editor of "Explainable AI: Interpreting, Explaining and Visualizing Deep Learning" (2019), co-editor of "xxAI–Beyond explainable AI" (2022), and organizer, workshops and tutorials on explainable AI, neural network compression, and federated learning. Dr. Samek is co-author of over 150 peer-reviewed papers, some ESI Hot (top 0.1%) or Highly Cited (top 1%).

Visiting two experiential AI laboratories in medicine

Vincenzo Valentini - U Cattolica Roma and Policlinico Gemelli

The technological innovation represented by artificial intelligence integrates and profoundly inspires the digital transformation of medicine, committing the whole of contemporary society to define, implement and regulate new platforms of operational integration in which human values, sustainability, technology and equity can interact for the benefit of patients and all individuals.

A fundamental characteristic of this change of epoch is the verifiability that what is hypothesised or planned is then actually of benefit to the end users. Two laboratories are presented in which the various protagonists of these new platforms have been brought together, right from the design of their architecture, in order to share experiences on the verification of the benefits of AI in medicine.

The Gemelli Generator laboratory aims to make available via AI resources the clustered data, advanced analyses, predictive models, synthetic data and distributed learning based on the Real World Data collected at the Policlinico Universitario A. Gemelli IRCCS in Rome over the last 25 years, in order to generate new evidence and operations through an interaction between clinicians, data scientists, as well as end users. The architecture of the laboratory and the value chain and some of its most significant activities will be shared.

The second laboratory is the Gemelli.ART. Besides traditional data science personnel and resources, it involves a clinical service unit in which over 11,000 cancer patients are treated each year. In this 'clinical laboratory', patients are exposed to different types of artistic content along their oncological journey with diversified, customised and interactive modes of enjoyment. The aim is to articulate a 'value-based medicine' by integrating the different value and physical components of the human in a personalised perspective, in which AI resources can be used to enhance usability and impact, in the hypothesis that we can achieve improved cure rates by prescribing exposure to the arts perceived as meaningful to the individual patient in addition to traditional cancer therapies.

Vincenzo Valentini is Full Professor of Radiation Oncology at the Università Cattolica S.Cuore of Rome and Director of Department of Radiology, Radiation Oncology and Hematology at Fondazione Policlinico Universitario A.Gemelli IRCCS of Rome. He is Deputy Scientific Director of Policlinico Universitario A.Gemelli IRCCS and Chair of AI & Real Word Data laboratory. He was President of ESTRO (European Society of Radiotherapy and Oncology) in 2011-2014.