

SMARTEST 1ST PROJECT MEETING

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Abstract

Report on the first official meeting of the SMARTEST project which took place at the CUMO in Noto, Sicily, on 9-10 September 2024

Keywords

SMARTEST; Digital Twins; Machine Learning; Ethics of AI.

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On September 9 and 10, 2024, the first official meeting of the (SMARTEST) project took place at the CUMO in Noto, Sicily. The project, [as presented in Volume 18, Issue 4](#), centers on studying and analyzing Digital Twin (DT) simulation through an ontological, philosophical, and epistemological approach, involving academic and researching institutions from Trento at [CNR-ISTC Laboratory for Applied Ontology](#), University of Milan at [Logic Uncertainty Computation and Information](#), and at [Department of Cognitive Science](#) at University of Messina. The event gathered key members of the SMARTEST research team and various guests from the academic world.

The workshop opened with a presentation by Balbir S. Barn from Middlesex University, who discussed a study conducted with the

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London Digital Twin Research Centre, examining DTs from a sociotechnical perspective. The study highlighted the methodological aspects of this approach through various public policy case studies. Key issues raised included challenges and limitations of DT modeling, such as managing simplification in complex systems, the margin of error in sociotechnical models, the role of DTs in understanding internal system operations versus acting as "black boxes," and the complexity of modeling language semantics.

Next, Giuseppe Primiero from the LUCI Laboratory at the University of Milan presented on the formal logical relationships between DT simulation models, underscoring the importance of formal verification in assessing the reliability of digital replicas of machine learning models. This evaluation process goes beyond a binary classification of reliability, focusing on more nuanced assessments based on specific validity conditions compared to the original models. This framework aims to ensure that digital replicas maintain both reliability and ethical integrity.

Alessandro Buda from the University of Milan introduced GAMERA: Generative AI Mitigation for Ethical and Responsible Algorithms. GAMERA proposes to expand the landscape of trust by providing a Kripke-style counterpart to Carnap-style semantics.

From the School of Computing at the University of Leeds, Vania Dimitrova, in her presentation titled "Developing City Infrastructure Ontologies to Support Complex Decision Making," prompted critical reflection on developing urban infrastructure in a smarter and more sustainable manner. She proposed holistic models that integrate knowledge and data, using the latter to validate and optimize cognitive models. Dimitrova emphasized the importance of adequate risk assessments, human oversight, and traceability, un-

derscoring the need for a “human-in-the-loop” approach involving stakeholders from the early stages to ensure effectiveness and participation.

Representing ISTC-CNR in Trento, Roberta Ferrario and Luca Bicchieri presented their work. Ferrario’s presentation, “Foundational Issues for an Ontology of Digital Twin,” focused on the ontological nature of DTs as artifacts and information objects. The final perspective of the work is that Digital Twins collectively form multiple models, encompassing both their physical counterparts (cyber-physical systems) and their social sphere influence (sociotechnical systems). Luca Bicchieri presented a study titled “Digital Twins for Trustworthy Human-Robot Interaction,” addressing trust issues in Human-Robot Interaction (HRI) and proposing an ontological approach. He demonstrated results from a robotic case study in a fruit-sorting experiment, using the DT approach as an alternative setting for evaluating trust in HRI compared to classic game-theory contexts.

John Symons from the University of Kansas explored the theme “Domain-Specific Machine Learning in Scientific Inquiry,” emphasizing how finite agents require support to progress in various tasks. Symons discussed the importance of developing systems that can reliably execute algorithms and overcome cognitive limitations. He addressed the No Free Lunch theorem, which posits that no universally superior learning algorithm exists for all problems. Furthermore, he considered the role of optimization in scientific inquiry and the principles of algorithmic learning, such as efficiency and hypothesis revision. In conclusion, he emphasized that a well-defined domain can become fertile ground for machine learning, promoting effective optimization methods.

Representing the University of Messina, Nicola Angius proposed

an epistemological and methodological analysis in a work titled “The Simulative Role of Neural Language Models in Brain Language Processing.” He discussed the trend of applying the synthetic method of cognitive science through the use of neural language models to simulate brain language processing. He proposed a co-simulation approach, highlighting how the epistemic opacity of the transformer architecture is tackled by using the brain itself to simulate the neural language model, giving the opportunity to acquiring knowledge and testing hypotheses about both system.

Lucia Guerrisi, also from the University of Messina, introduced a modeling approach involving Deep Learning (DL) as a simulative method. The case presented concerned the Meteorological Neural Network 2, proposing a DL approach for model verification and validation. The study demonstrated how modeling in scientific contexts can be an approximate simulative method, especially in cases where structural similarities are identified through network interpretation.

The workshop concluded with Alessio Plebe’s “Determinism in Neural Language Models” on the benefits of non-determinism in neural language models and its importance as a strategic element in their design. He highlighted the role of noise and variability in enhancing neural network performance. Exploring concepts like stochastic resonance, he discussed how noise influences biological processes and suggested similar mechanisms for computational models. Through nuclear sampling he illustrated how variability and non-determinism can enrich deep learning applications.

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