Report on the Conjoint Workshop: IMT Scuola Alti Studi and the University of Virginia School of Data Science

Brian Wright[1], Sibilla de Guida[2], Diego Garlaschelli[2], Don Brown[1], Mirco Tribastone[2], Massimo Riccaboni[2], Luca Cecchetti[2], Gianluca Guadagni[2], Marco Paggi[2], Tommaso Gili[2], Francesca Setti[2], Valentina Elce[2], Alessandra Federici[2], John Darrell Van Horn[1*], and Emiliano Ricciardi[2**]

[1]UVA School of Data Science, University of Virginia, Charlottesville, VA 22903 USA

[2]IMT Scuola Alti Studi, Piazza S. Francesco, 19 - 55100 Lucca, LU, Italy

Contact: *jdv7g@virginia.edu; **emiliano.ricciardi@imtlucca.it

Abstract

On May 23, 2024, the IMT School of Advanced Study and the University of Virginia School of Data Science co-hosted a workshop at the Cappella Guinigi in the San Francesco Complex, Lucca, Italy. The event aimed to highlight the research areas of both institutions, build relationships, and facilitate faculty and graduate student visits, laying the groundwork for future collaborations. This initiative follows a memorandum of agreement signed in 2023 to support mutually beneficial projects. The workshop featured fourteen intensive research talks covering AI and data science applications in education, security, economics, and neuroscience. Highlights included discussions on generative models for intelligent assistants, data-driven research in human-machine interaction, network science, supervised contrastive learning for time series classification, systems security modeling, and advanced AI applications in neuroscience. Key areas identified for future collaboration include digital twins, dynamical systems, and the application of advanced AI methods in neuroscience. This workshop exemplifies the potential of international academic partnerships to drive scientific discovery and enrich educational experiences.

Introduction

The IMT Scuola Alti Studi, a school for advanced graduate study located in Lucca, Tuscany, recently signed a Memorandum of Understanding (MOU) with the UVA School of Data Science (UVA SDS), a pioneering institution at the University of Virginia dedicated to advancing the field of data science through cutting-edge research, interdisciplinary collaboration, and innovative education programs. UVA SDS and IMT School are presently working on a range of collaborative research efforts aimed at advancing the frontiers of data science applied to economics, networks, systems, medical research, and neuroscience. Leveraging the complementary strengths of both institutions, this partnership seeks to foster interdisciplinary exchange, facilitate faculty and graduate student visits, and cultivate joint research initiatives across all disciplines.

Pursuant to these goals, the IMT and UVA SDS hosted a conjoined workshop on the 23rd of May 2024, featuring lectures from both institutions. The workshop was held in the Cappella Guinigi at the San Francesco Complex hosted on the campus of IMT in Lucca, Italy. The goals of the workshop were to highlight the research areas of both schools, build and extend relationships, and facilitate faculty and graduate student visits to lay the groundwork for substantive future partnerships. This effort builds on a previously established relationship that led to the signing of a school-level MOU in 2023 aimed at providing support to explore mutually beneficial collaborations. The following is a summary of the research presented at the workshop and areas identified as having high potential for collaboration to pursue moving forward.

Workshop Summary

The workshop opened with Professor Brian Wright from UVA SDS, who discussed the role of generative models as they relate to the development of Intelligent Assistants and the human-computer dynamics associated with their usage. He evaluated current methods and highlighted opportunities for improvement, emphasizing the need for research to assess the effectiveness of AI in classrooms both from a technical and emotional perspective. Professor Sibilla Di Guida (IMT) followed with a presentation on ongoing data-driven research at IMT School within the OPEN LAB framework. She showcased various projects on innovation, human-machine interaction, healthcare technologies, and neuroscience, emphasizing a project on strategic reasoning using eye-tracking technology.

Professor Diego Garlaschelli (IMT) then reviewed recent developments in network science, focusing on information-theoretic methods for pattern detection, network reconstruction, and optimal data compression. Professor Don Brown (UVA SDS) then introduced a novel approach called Supervised Contrastive Learning for Time Series Classification (SupCon-TSC), aimed at enhancing the performance of multivariate time series classification tasks, especially with limited labeled data. Professor Mirco Tribastone (IMT) then discussed systems security modeling and analysis, covering lifelong learning, data and model compression, urban dynamics, and the application of AI in misinformation detection.

During the afternoon session, Professor Massimo Riccaboni (IMT) examined firm survival theories using machine learning frameworks to analyze the survival probabilities and performance of firms in Italy and the Netherlands. Professor Luca Cecchetti (IMT) then explored advanced data analysis techniques in affective science to better understand the dynamic nature of emotions and their neural underpinnings. Next, Professor Gianluca Guadagni (UVA SDS) then provided an overview of generative diffusion models in machine learning and included several practical applications.

The program continued with Professor Marco Paggi (IMT) discussing the development of high-fidelity digital twin models for materials and processes by the MUSAM research unit, focusing on engineering applications. This was followed by Professor Tommaso Gili (IMT) presenting methods for analyzing the complexity of biological and material systems using complex networks theory. Professor John Darrell Van Horn (UVA SDS) concluded the faculty presentations with the introduction of the concept of "Digital Neural Organoids" (DigiNoid), which combines neural networks with organoid models to simulate neurobiological processes and enhance learning systems.

The workshop concluded with a discussion by IMT post-doctoral fellows Francesca Setti, Valentina Elce, and Alessandra Federici on various aspects of neuroscience and data science. The event featured fourteen research-intensive talks from a diverse set of topics in AI and data science with applications across education, security, economics, and neuroscience, offering a comprehensive overview of cutting-edge research and methodologies.

Upon completion of the workshop, several research areas were identified with high potential for collaboration. These areas include human center computing with work presented by Professors Wright, Di Guida, and Cecchetti all of which leverage AI methods and tools to better understand human behavior or decision-making. Also, the work presented by Professors Paggi and Tribastone both from IMT and Brown from UVA were identified as having potential from both the development of data-driven systems and from novel approaches to data generation and analysis while leveraging health as an application domain. The final category relates to the application of theory from Neuroscience as a test bed for advanced AI methods that covered topics related to the computational processes of the neurological systems as presented by Professor Van Horn from UVA along with Professors Garlaschelli and Gili from IMT.

Conclusions

The recent MOU between IMT Scuola Alti Studi and the UVA School of Data Science marks a significant step forward in fostering international collaboration in data science and AI research. This partnership leverages the complementary strengths of both institutions to drive interdisciplinary exchange, facilitate faculty and graduate student visits, and cultivate joint research initiatives. The collaborative efforts aim to advance the frontiers of data science as applied to economics, networks, systems, medical research, and

neuroscience. By combining their expertise, IMT and UVA SDS are well-positioned to address complex scientific challenges and generate innovative solutions.

The conjoined workshop held in Lucca, Italy, exemplified the potential of this US-Italian partnership. The event featured a series of lectures from leading researchers at both institutions, showcasing cutting-edge AI-driven research in areas such as generative models for intelligent assistants, network science, supervised contrastive learning, and systems security modeling. The presentations highlighted opportunities for improvement and collaboration, particularly in understanding human-computer dynamics, enhancing time series classification tasks, and developing high-fidelity digital twin models. The exchange of ideas and methodologies during the workshop set the stage for future joint research projects. This partnership not only aims to drive scientific discovery but also to enhance the educational experiences for students and researchers, demonstrating the profound impact of international academic collaborations.

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