

# THURSDAY, MAY 23<sup>rd</sup>, 2024

Cappella Guinigi,  
San Francesco Complex



## CONJOINT WORKSHOP

9.00 am **Opening and welcome**

9.30 am **Brian Wright**, *Quantitative Foundation Associate Professor of Data Science*

### **AI TOOLS IN THE CLASSROOM: LANDSCAPE AND OPPORTUNITIES**

Professor Wright will provide an overview of research and practices as it relates to AI tools in the advancement of learning with an emphasis on higher education settings. This will include an evaluation of current methods to allow for a discussion of weaknesses and opportunities. Professor Wright will conclude with potential avenues to design studies to evaluate the effectiveness of AI tools in classroom settings.

10.30 am **Sibilla Di Guida**, *AXES, IMT School*

### **DATA-DRIVEN RESEARCH AT IMT, ONGOING PROJECTS AND ROLE OF THE OPEN LAB**

Professor Di Guida will present examples of data-driven research conducted at IMT within the framework of OPEN LAB, an open laboratory resulting from IMT's recognition as one of Italy's Departments of Excellence. Our diverse projects encompass topics including "Innovation," "Human-Machine Interaction," "New Technologies for Healthcare & Neuroscience," "Work & Telecommuting," "Mobility & Tourism," and "Microservices and Serverless Applications." One such project delves into unraveling strategic reasoning and its development in interactive contexts. Utilizing eye-tracking technology for data collection provides profound insights into information acquisition processes. While employing traditional analysis methods, novel methodologies developed by our students demonstrate the efficacy of domain-specific feature engineering in scanpath analysis, surpassing baseline benchmarks. By leveraging eye-movement patterns to classify participants based on strategic abilities, our study contributes to a comprehensive understanding of human behavior across diverse contexts.

11.00 am **Coffee Break**

11.30 am **Diego Garlaschelli**, *NETWORKS, IMT School*

### **NETWORK ANALYSIS AND INFORMATION-THEORETIC DATA SCIENCE METHODS**

Network science at IMT Lucca encompasses a broad spectrum of research, from abstract mathematical modelling to practical applications in biology, ecology, social sciences and economics. I will present an overview of recent results revolving around the development of novel information-theoretic methods of analysis of network data and time series. These methods are relevant for pattern detection, network reconstruction from partial information, coherent multi-scale modelling, and optimal compression of structured data.

# CONJOINT WORKSHOP

**12.00 pm**     **Don Brown**, *QIM Distinguished Professor of Data Science and Senior Associate Dean for Research*

## **UNIVERSAL REPRESENTATION LEARNING FOR MULTIVARIATE TIME SERIES**

Multivariate Time Series Classification (MTSC) task predicts labels for given time series data. Recent advancements in deep learning-based approaches have shown promising performance compared to traditional methods for MTSC tasks. However, the success of these approaches heavily relies on access to a substantial amount of labeled data. Unfortunately, obtaining such labeled data is often time-consuming and expensive, especially in real-world domains like medicine, where domain experts are required to annotate the data. Without enough labeled examples, the models struggle to learn discriminative features, leading to poor generalization performance. To tackle this issue, we developed a novel approach: Supervised Contrastive learning for Time Series Classification (SupCon-TSC). In this lecture, Dr. Brown will describe this method, its performance, and examples of its application.

**12.30 pm**     **Mirco Tribastone**, *SySMA, IMT School*

## **ML AND AI FOR SYSTEMS SECURITY, MODELING, AND ANALYSIS**

Abstract: This talk will provide an overview of the active research lines at IMT on machine learning and artificial intelligence within the unit SySMA (Systems Security, Modeling, and Analysis), covering both foundational and applied topics. I will present recent results on lifelong learning using powerful analytical tools from the calculus of variations, emphasizing the need for an agent to adapt to the information stream. Other theoretical results concern data and model compression, with the aim of transforming networks into lower-dimensional ones that preserve the original performance. I will then move on to research of urban dynamics to understand intrinsic patterns and spatiotemporal characteristics of cities and citizens through various embeddings. Finally, I will discuss applications of AI and ML to misinformation and fake news detection.

**1.00 pm**     **Lunch Break**

**2.00 pm**     **Massimo Riccaboni**, *AXES, IMT School*

## **LEARNING AND THE SURVIVAL OF FIRMS**

It is well known that the probability of exiting the market decreases with the age of the firm. However, unproductive firms (e.g., zombie firms and lifestyle firms) can survive for a long time as well. We advance theories of firm learning and survival to predict and explain the selection and growth of productive and unproductive firms using rich administrative data on the population of firms in the Netherlands and Italy. In particular, we apply newly developed machine learning frameworks to quantify the heterogeneity in firm survival probabilities and their performance over time.

**2.30 pm**     **Luca Cecchetti**, *MOMILAB, IMT School*

## **LEVERAGING ADVANCED DATA ANALYSIS IN AFFECTIVE SCIENCE**

Affective science seeks to understand the complex interplay between emotions, cognition, and behavior. However, traditional data analysis methods often struggle to capture the dynamic and situational nature of emotions, which unfold over time and are influenced by contextual factors. This presentation explores how advanced data analysis techniques can be harnessed to unlock deeper insights into emotional processes and their neural underpinnings.

# CONJOINT WORKSHOP

- 3.00 pm **Gianluca Guadagni**, *Associate Professor of Data Science*  
**GENERATIVE DIFFUSION MODELS**  
Dr. Guadagni will provide a mathematical introduction to diffusion models in machine learning with some practical applications for these models.
- 3.30 pm **Marco Paggi**, *MUSAM, IMT School*  
**HIGH-FIDELITY AND DATA-DRIVEN DIGITAL TWIN MODELS WITH APPLICATIONS TO ENGINEERING SCIENCE**  
The research unit MUSAM -Multi-scale Analysis of Materials- is engaged in the development of digital twin models for materials and processes.
- 4.00 pm **Coffee Break**
- 4.30 pm **Tommaso Gili**, *NETWORKS, IMT School*  
**DATA MINING OF BIOLOGICAL AND MATERIAL SYSTEMS: HOW COMPLEX SYSTEMS AND NETWORKS CAN HELP**  
The spatial and temporal complexity of real-world data offers everyday challenges to their analysis and interpretation that grow progressively together with their amount and our need for natural phenomena forecasting. This is even more difficult if we think about the variability of biological systems and the disordered nature of many materials. In this talk, we show how the methods developed in the context of complex systems, especially those regarding complex networks theory, can help to describe the many-body interactions typical of such systems at the mesoscopic scale, joining the microscopic with the macroscopic regimes.
- 5.00 pm **John Darrell Van Horn**, *Professor of Psychology and Data Science*  
**DIGITAL NEURAL ORGANIDS: THE POTENTIAL FOR NEUROBIOLOGICALLY INFORMED LEARNING OBJECTS**  
Organoids, grown from neural stem or progenitor cells, mimic miniature organ structure and function. They aid in studying organ development, disease modeling, and drug testing. In contrast, computational neural networks, inspired by the brain's most basic structures, process information through interconnected network nodes. Combining the concept of the organoid with that of the neural network can be employed to computationally simulate complex neurobiological processes and enhance understanding in brain network theory and learning systems. In this talk, Dr. Van Horn will introduce the "Digital Neural Organoid" or "DigiNoid", discuss their creation, properties, dynamics, and potential utility as an intriguing test-bed for probing biologically informed computational learning systems which more closely emulate living neural systems.
- 5.30 pm **Francesca Setti, Valentina Elce, Alessandra Federici**, *Post Doctoral Fellows, MOMILAB*  
**BITS OF NEUROSCIENCE AND DATA SCIENCE**
- 6.00pm **Closing remarks**